ecotech
environmental monitoring solutions

EC9832

Carbon Monoxide Analyser

Service Manual

Revision: B

www.ecotech.com

Table of Contents

Manual History

This manual is the combination of two previous versions which have now been merged into one document to cater for the continuing development of the EC9800 series analyzers. The original manuals were:

EC9832 Service Manual , PN: 98320002, Rev. F, September 1998.

The scope of this new manual covers the following analyzers:

EC9832 Carbon Monoxide Analyzer, (A-Series), PN: 98321000-100.

Both of the instruments are Manufactured by Ecotech P/L in Australia and support the new (SMD) Microprocessor Board (Part number 98000063-4). This manual is current for firmware version 1.03 and above.

This manual should only be used in conjunction with the *EC9832 Carbon Monoxide Analyzer, Operation Manual PN: 98307600 Rev. B, May 2007*

Ecotech Manual ID:	MAN 0011
Manual PN:	98320005.
Current Revision:	B.
Date Released:	May 2007.
Description:	EC9832 Carbon Monoxide Analyzer, Service Manual, A & B Series.

Revision History

Rev	Date	Summary	Affected Pages
A	April 2005	New Release for new Microprocessor Board. A & B series Combined. Based on original manuals.	All
B	May 2007	Updated language and links within pdf manual created.	All

Safety Requirements

To reduce risk of personal injury caused by electrical shock, follow all safety notices and warnings in this documentation.

This equipment should *always* be used with a protective earth installed.

The EC9832 is compliant with the requirements of EN61010-1 A2:1995, *Safety Requirements for Equipment for Measurement, Control, and Laboratory Use*.

If the equipment is used for purposes not specified by the manufacturer, the protection provided by this equipment may be impaired.

Replacement of any part should only be carried out by qualified personnel, only using parts specified by the manufacturer. Always disconnect power source before removing or replacing any components.

Equipment Rating

100-120/220-240V~ ±10%

50/60 Hz

250 VA max

FUSE: 5/3.15A T 250V

All wiring must be in accordance with local norms and be carried out by experienced personnel.

Service and Spare Parts

For world wide customer service & spare parts contact ECOTECH:

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Phone:	**+61 1300 364 946**
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1.0 Installation

1.1 Initial Check

Verify that the serial number label on the documentation and the serial number(s) on the analyzer match.

Check to make certain your instrument arrived undamaged. If you find damage, report it as described in the preface, on the page titled *Claims for Damaged Shipments and Shipping Discrepancies* in the Operation manual.

Analyzers are shipped ready to power up. Occasionally, however, rough handling during shipment causes dislodged PC boards, disconnected cables, or incorrectly positioned switches. Verify that your instrument is in operating condition by performing the following procedure.

1.1.1 <u>Remove the Top Cover</u>

Grasp the front top corners of the front panel and pull forward. The panel will pop loose and pivot forward. See Figure 1. The top cover retaining hardware is then visible as shown in Figure 2. Use a screwdriver to unscrew the two captive screws. When the two captive screws are loosened, slide the cover backward about 4 inches and lift the top cover straight up.

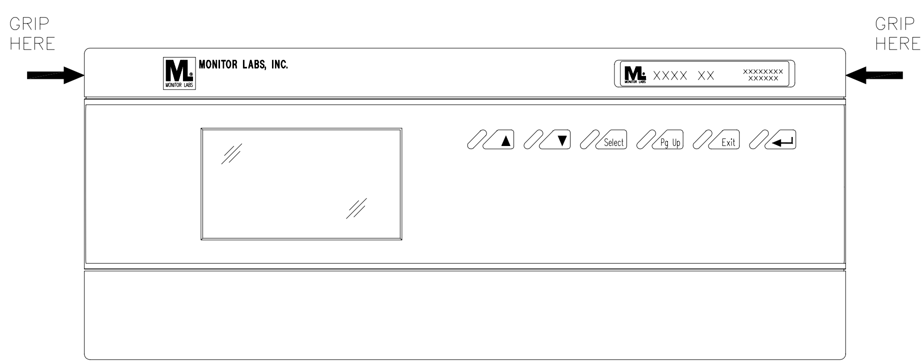

Figure 1. Opening the Front Panel

1.1.2 Service Switch

Opening the front panel allows a view of the secondary panel where four switches are visible. The position of the toggle switches for operating mode is:

DC Power ON
Pump ON
ServiceIN

The Reset switch is not a toggle switch and is only activated when pressed. It resets the microprocessor. The pump switch is not applicable to the B-line instrumentation because the flow is generated through the use of an external pump.

When in the OUT position, the Service switch sets the `OUT OF SERVICE` bit in the 50-pin I/O interface and in the status word from the serial port. The OUT position has no other effect on the operation or validity of the data obtained from the analyzer. When the Service switch is set from OUT to IN, the instrument returns to the normal operating conditions.

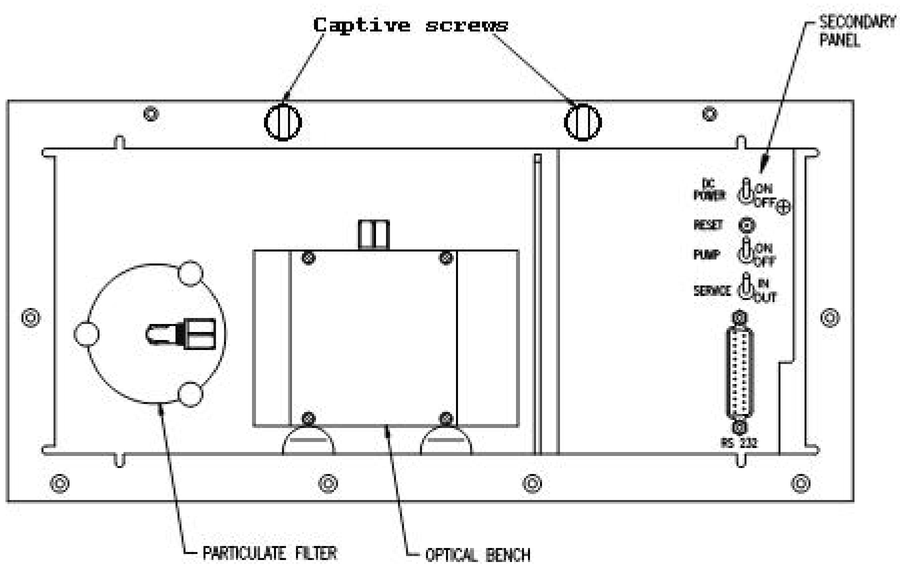

Figure 2. The Secondary Panel (A Series)

1.1.3 Inspect the Components

Verify that the components were not damaged in shipping. If any PC boards are dislodged or cables disconnected, follow the instructions below.

1.1.4 Reinsert Dislodged Boards

The bottom edge of the boards must be held in place by the guides. The top of the boards must be attached to the metal bulkheads by the plastic or metal studs with spring tips.

1.1.5 Cable Connections

The cable connectors and the board connectors must be matched securely in place for correct connection. The red indicator on each cable must be positioned at the arrowhead mark on the board connector. Make the connection by pressing the cable connector into the mating connector until a click is heard. Then, fold the retainers inward to secure the connection (see Figure 3).

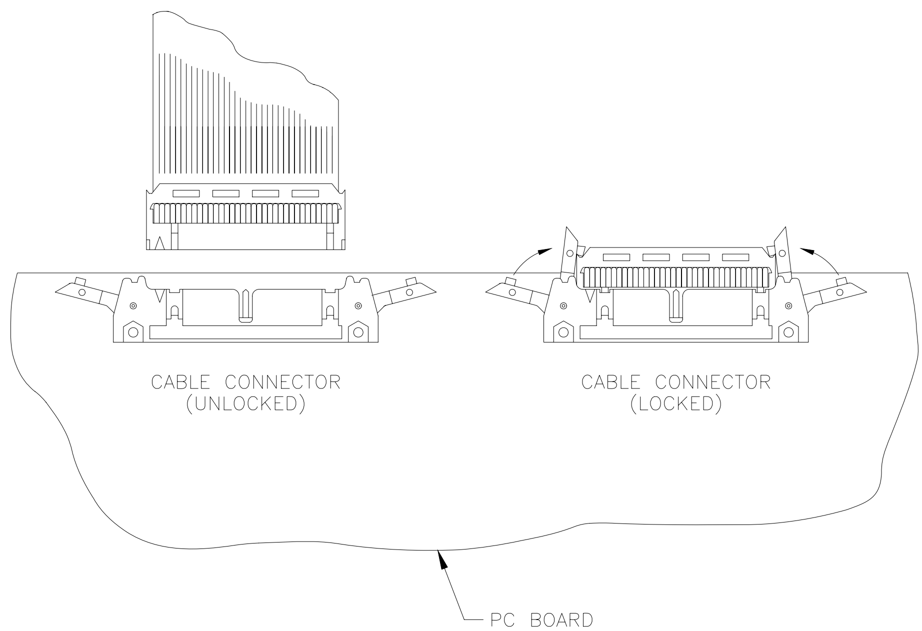

Figure 3. Cable Connections

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2.0 Theory of Operation

Carbon monoxide absorbs infrared radiation (IR) at wavelengths near 4.7 microns; therefore, the presence and the amount of CO can be determined by the amount of absorption of the IR. The EC9832 analyzer uses gas filter correlation to compare the detailed IR absorption spectrum between the measured gas and other gases present in the sample being analyzed. A highly concentrated sample of the measured gas, i.e., CO is the filter for IR transmitted through the analyzer, thus gas filter correlation.

The process further defined consists of radiation from the IR source encountering a gas filter wheel alternating between CO, N_2, and a mask. The radiation passes through a multiple pass measurement cell where the sample gas absorption process occurs, then through a narrow-band-pass filter to limit absorption to optical wavelengths of interest for CO absorption, after which it encounters the IR detector where the amount of absorption is measured.

The N_2 filter in the gas filter correlation wheel is transparent to IR and yields a measure beam that can be absorbed by CO in the measurement cell. The CO filter in the wheel yields a beam that cannot be further attenuated by the CO in the measurement cell, thus it is a reference beam. The mask creates a signal used to determine the strength of the other two signals.

The CO concentration in the measurement cell absorbs the measure beam and does not absorb the reference beam, modulating the IR radiation, or detector input signal between the gas filters. Other gases absorb the reference and measure beams equally and thus do not cause modulation of the detector signal. Using this method, the system responds specifically to CO.

The EC9832 analyzer uses the advanced digital Kalman filter. This filter provides the best possible compromise between response time and noise reduction for the type of signal and noise present in ambient air analyzers and their application.

Ecotechs' implementation of this filter enhances the analyzer's measurement method by making the filter time base variable depending on the change rate of the measured value. If the signal rate is changing rapidly, the instrument is allowed to respond quickly. When the signal is steady, a long integration time is used to reduce noise.

The system continuously analyzes the signal and uses the appropriate filtering time. Ecotech's analyzers have passed USEPA equivalency testing using this advanced signal filtering method.

2.1 Instrument Description

The instrument is designed in a modular format consisting of a power/microprocessor module and a sensor module. The power/microprocessor module contains the power supply, voltage regulators, and the system microprocessor. The sensor module contains all components necessary to measure the pollutant gas. The slight variations between the A and B series analyzers are illustrated using system block diagrams (Figure 4 & Figure 5) and major component layout diagrams (Figure 6 & Figure 7).

2.1.1 Power/Microprocessor Module

The power/microprocessor module can be described in three sections, the power supply, the voltage regulator, and the microprocessor.

2.1.1.1 Power Supply

The power supply is a self-contained unit housed in a steel case. It is designed to meet UL, VDE, CSA, and other regulatory requirements. It converts 99 to 264 VAC 50/60 Hz to 12 VDC power for distribution within the analyzer. The power supply also furnishes a 250 msec power extension in the event of power failure to allow the computer to store data before the power failure can affect it.

2.1.1.2 Voltage Regulator

The voltage regulator board regulates and distributes the different voltages needed throughout the system: 12 VDC to +5 VDC for the digital circuitry and 12 VDC to ±10 volts for analog circuitry. An additional +15 VDC supply is present to power the microprocessor display supplies and analog output circuits. The voltage regulator also furnishes a 300 msec power extension in the event of power failure to allow the computer to store data before the power failure can affect it.

2.1.1.3 Microprocessor

The microprocessor board contains a battery backed clock/calendar and an onboard 16-bit microprocessor (MC68HC12) operating at 16 MHz. The microprocessor board is the control center for input and output apparatus such as the 2 inch by 4 inch liquid crystal display (LCD), keyboard switches, the serial ports, and the 50-pin I/O connector on the rear panel. The 50-pin I/O connector input accepts control lines from the rear panel and sends status and failure signals to solid state relay drivers. Support circuitry for the liquid crystal display includes a -20 V power supply and digitally adjusted potentiometers for contrast level.

All analog voltages from the sensor assembly are digitized by the analog-to-digital (A/D) converter for microprocessor use. Digital-to-analog (D/A) conversion of three channels is used to send 0 to 20 mA analog signals to the 50-pin I/O connector.

The microprocessor has electrically erasable ROMs which store the operating program and internally logged data. Program upgrades can be easily made through the serial port. The Service and Reset switches are located on the front of the board and are accessible when the top is removed or when the front panel is opened. The microprocessor also has provisions for optional USB and TCIP connections.

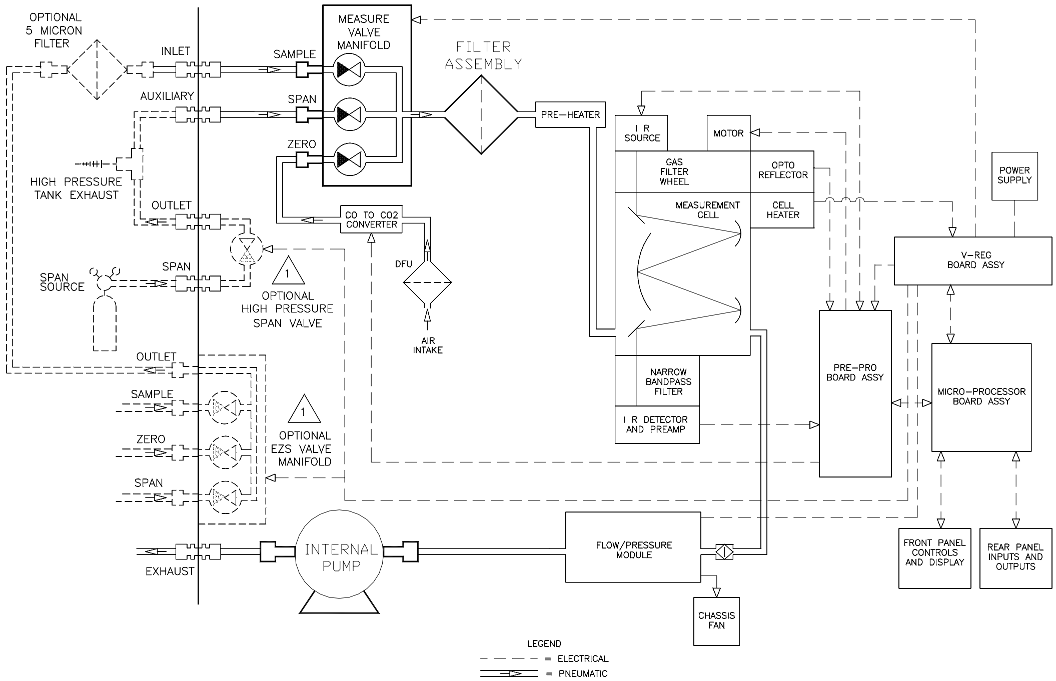


Figure 4. System Block Diagram (A Series)

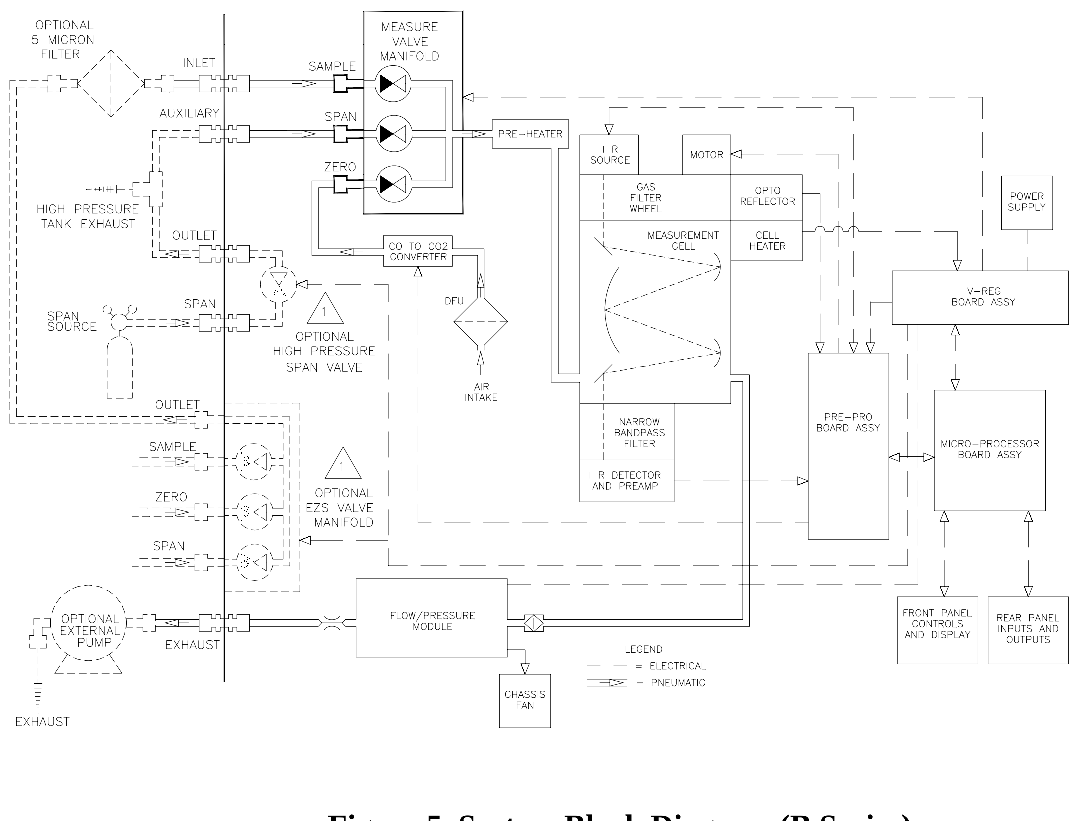


Figure 5. System Block Diagram (B Series)

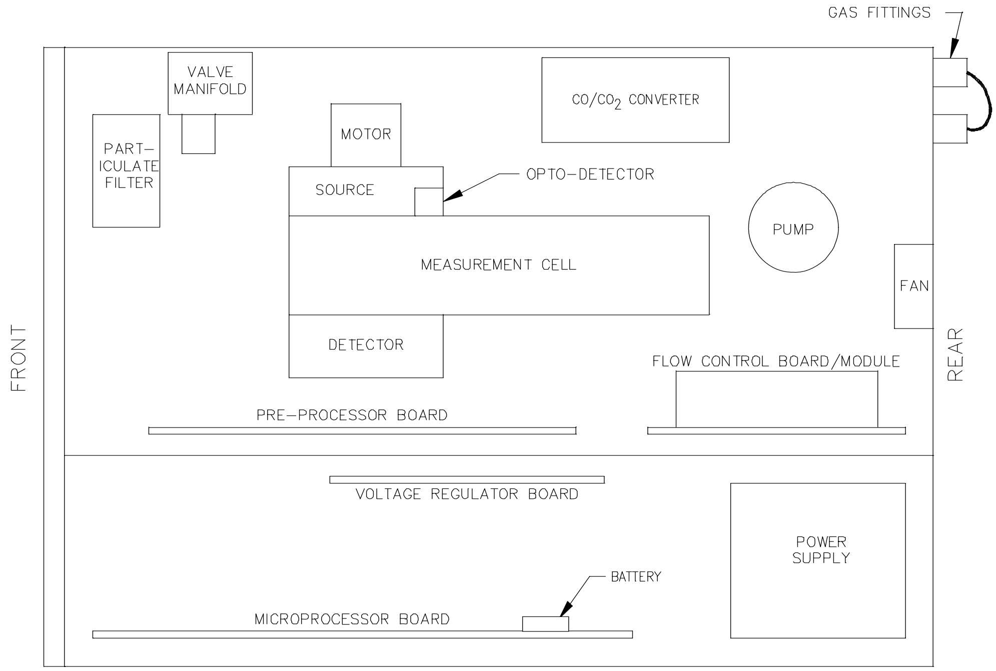


Figure 6. Major Components (A Series)

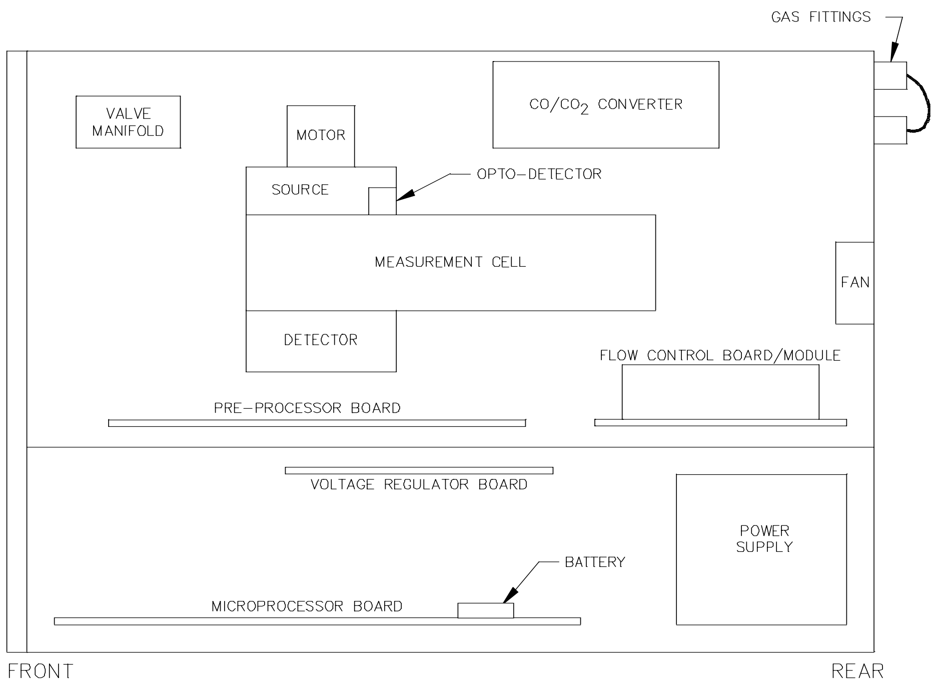


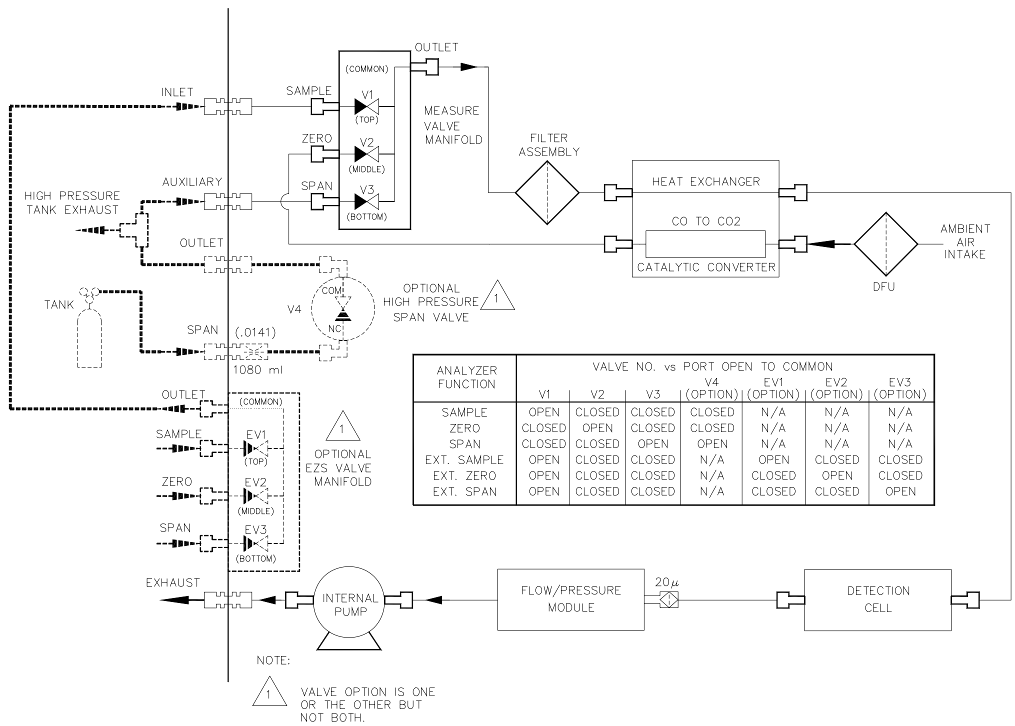
Figure 7. Major Components (B Series)

2.1.2 Sensor Module

The sensor module can be divided into three areas of description: pneumatics, optics, and electronics.

2.1.2.1 Pneumatics

The pneumatic system continuously supplies sample air to the measurement cell at a rate that allows the sample to be measured before exiting the analyzer. The pneumatic system flow is illustrated in Figure 8 & Figure 9. The pump causes sample air to be drawn into the sample inlet and through the 5 micron particulate filter. The inherent differences between the A and B series analyzers is the method of flow control and the pump used. These differences will be discussed in the following sections.



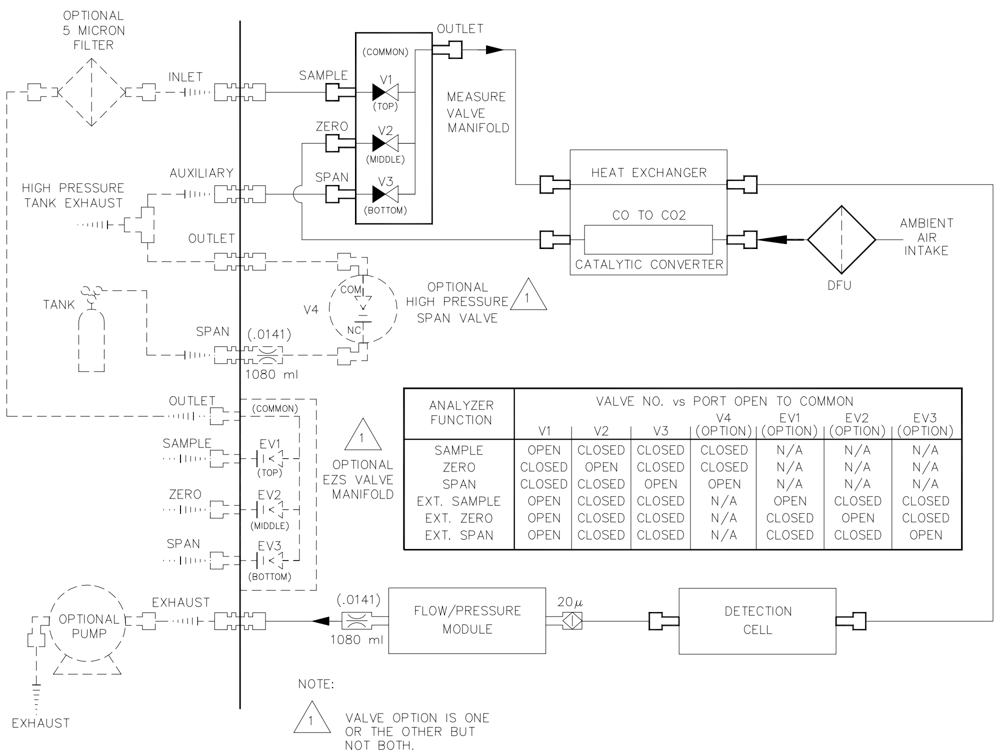
ANALYZER FUNCTION	VALVE NO. vs PORT OPEN TO COMMON						
	V1	V2	V3	V4 (OPTION)	EV1 (OPTION)	EV2 (OPTION)	EV3 (OPTION)
SAMPLE	OPEN	CLOSED	CLOSED	CLOSED	N/A	N/A	N/A
ZERO	CLOSED	OPEN	CLOSED	CLOSED	N/A	N/A	N/A
SPAN	CLOSED	CLOSED	OPEN	OPEN	N/A	N/A	N/A
EXT. SAMPLE	OPEN	CLOSED	CLOSED	N/A	OPEN	CLOSED	CLOSED
EXT. ZERO	OPEN	CLOSED	CLOSED	N/A	CLOSED	OPEN	CLOSED
EXT. SPAN	OPEN	CLOSED	CLOSED	N/A	CLOSED	CLOSED	OPEN

Figure 8. Pneumatic Diagram (A Series)

Particulate Filter. The particulate filter is designed to remove particles larger than 5 microns and to expose the sample to only nonreactive materials of Kynar, Teflon, and Viton. The filtering agent is a 47 mm diameter, 5 micron filter. This filter is not supplied with the B series analyser and must be purchased as an option.

*CO-CO_2 Converter***.** The CO-CO_2 catalytic converter uses platinum heated to 90° C as a conversion agent. Heating the catalytic agent assures conversion of 0 to 200 ppm CO to less than 0.1 ppm CO, even in the presence of 2% water.

During the startup and auto-zero cycles sample is disconnected and air is pulled into the system through the CO-CO_2 converter and into the measurement cell. This provides the analyzer with a stable reference of zero air to automatically correct for changes in the measurement path.



ANALYZER FUNCTION	VALVE NO. vs PORT OPEN TO COMMON						
	V1	V2	V3	V4 (OPTION)	EV1 (OPTION)	EV2 (OPTION)	EV3 (OPTION)
SAMPLE	OPEN	CLOSED	CLOSED	CLOSED	N/A	N/A	N/A
ZERO	CLOSED	OPEN	CLOSED	CLOSED	N/A	N/A	N/A
SPAN	CLOSED	CLOSED	OPEN	OPEN	N/A	N/A	N/A
EXT. SAMPLE	OPEN	CLOSED	CLOSED	N/A	OPEN	CLOSED	CLOSED
EXT. ZERO	OPEN	CLOSED	CLOSED	N/A	CLOSED	OPEN	CLOSED
EXT. SPAN	OPEN	CLOSED	CLOSED	N/A	CLOSED	CLOSED	OPEN

Figure 9. Pneumatic Diagram (B Series)

2.1.2.1.1 A series Flow Control

*Flow Control Module***.** The sample flow rate is monitored by measuring the pressure drop across a calibrated flow restrictor. The upstream pressure of this restrictor is the sample cell pressure. Mass flow through the restrictor is computed from the upstream and downstream pressures. Since the pressure transducers used are temperature sensitive, they are mounted in a temperature controlled block.

Sample Pump. The rotary vane-type pump is powered by a brushless DC motor. Since the pump is working with a very light load, it rotates very slowly, resulting in very little bearing or vane wear. The estimated pump life is in excess of 5 years. The Pump speed is controlled by a DC input voltage derived from two digital potentiometers under microprocessor control on the flow control board. The pump speed is varied to achieve desired sample flow rate.

Rear Fan. The fan speed is controlled by a variable input voltage derived from a digital potentiometer under microprocessor control on the flow control board. The fan speed is controlled to begin operating at about 30° C chassis temperature and increase its speed in a linear fashion until it is at full operating speed about 50° C chassis temperature.

2.1.2.1.2 B series Flow Control

*Flow Block***.** The sample flow rate is controlled by a critical orifice in the flow block. Displayed flow through the analyzer is calculated based upon flow through the orifice at a given upstream pressure. This upstream pressure is monitored by a calibrated pressure transducer, with the assumption made that the downstream side of the orifice is at less than half the pressure of the upstream side by the sample pump (this is required for the orifice to remain critical). Flow through the analyzer is verified by measuring the differential (gauge) pressure between the upstream side of the orifice and ambient pressure.

Sample Pump. The sample pump is supplied as an option by Ecotech and is connected to the exhaust of the analyzer. This vacuum pump must be capable of maintaining at least 1/2 atmosphere (approximately 15” Hg or 50 kPa at sea level) in order to keep the orifice flow critical.

Rear Fan. The fan speed is connected directly to the flow block and is operated continuously to keep the chassis temperature low.

2.1.2.2 Optics

The optics of the EC9832 analyzer include an IR source, an optical detector, a gas filter correlation wheel, measurement cell, narrow-band-pass filter, IR detector, and preamp board as described in the following paragraphs. Figure 10 illustrates the optical path.

*IR Source***.** The IR source is a heated resistor that generates broad-band infrared radiation and irradiates the gas filter correlation wheel.

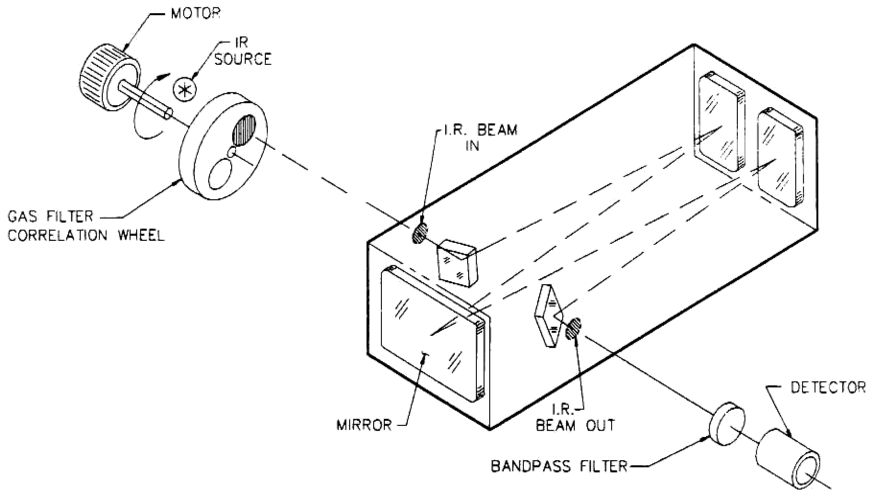


Figure 10. **Illustrated Optical Path**

*Gas Filter Correlation Wheel***.** The gas filter correlation wheel includes two gas filled sapphire chambers and mask areas**.** As the wheel rotates, the IR beam passes through either 1) the reference chamber which is filled with CO, removing the CO-sensitive wavelengths which are centered at 4.7 microns and passing the CO-insensitive wavelengths; 2) the measure chamber which is filled with nitrogen and passes the CO-sensitive wavelengths; or 3) a mask which blocks the beam**.** When the mask blocks the transmission of IR, the detector generates the mask signal used as a zero reference to determine the strengths of the other two signals**.** The differences between signals are used to compute the concentration of CO**.** Figure 11 shows the gas filter correlation wheel**.** The wheel is mounted on a shaft driven by a brushless DC motor.

*Opto-detector***.** A reflective optical detector reacts to timing marks on the periphery of the wheel and generates a signal indicating when the center of each sector is the target of the IR source beam.

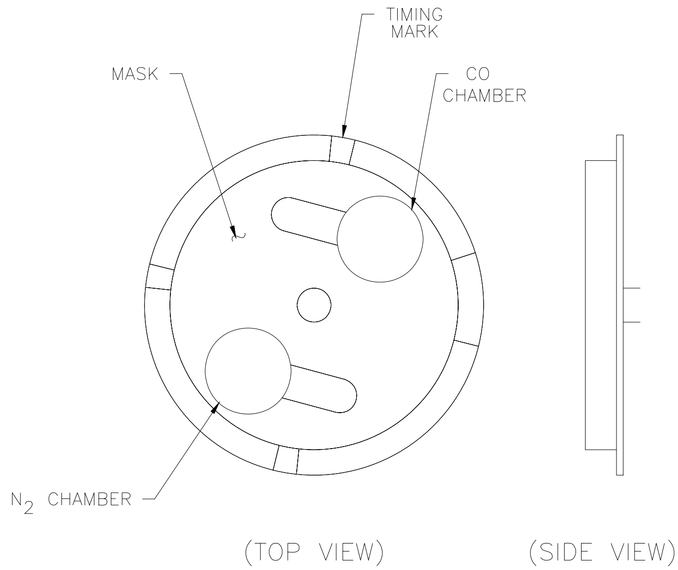


Figure 11. Gas Filter Correlation Wheel

*Measurement Cell***.** The IR next enters the multiple pass optical measurement cell where it travels a mirror folded one meter path through the sample gas before exiting the cell. See Figure 10.

The cell housing is kept at a controlled temperature and the thermistor monitoring this temperature is reported as `CELL TEMP` on the `SYSTEM TEMPERATURES` screen. This temperature is used for gas law corrections.

*Narrow-Bandpass Filter***.** The broadband radiation from the IR source that passes through the gas filter wheel and measurement cell is filtered again by the narrow- band-pass filter. Only the CO-sensitive portion of the band centered at 4.7 microns passes through the filter. The removal of wavelengths sensitive to other gases reduces interference.

*IR Detector***.** The lead selenide IR detector is chilled to -20° C. When IR centered at 4.7 microns shines on the detector, it changes the current flowing through it. This change produces the detected signal.

2.1.2.3 Electronics

*Preamplifier Board***.** The preamplifier (preamp) board converts the current from the IR detector to voltage and amplifies it to a waveform containing a reference voltage peak, measure voltage peak, and the mask voltage valley.

*Preprocessor***.** The preprocessor contains circuitry for sampling the amplitude of the reference and measure pulses, a regulator to keep the IR source at constant intensity, two heater controls, and miscellaneous logic to generate test signals. One heater circuit controls the CO to CO_2 converter to +90° C, while the other controls the adjustable mirror plate in the measurement cell to 50° C.

An *optodecoder* circuit separates detected timing marks on the gas filter correlation wheel into logic signals for comparison of the reference and measure pulse amplitudes. Circuitry is included to convert the pulse amplitudes into direct current (DC) to balance the two detected DC signals for zeroing, and to amplify the resultant signal with a programmable gain amplifier under control of the microprocessor. The board also contains an EAROM which contains device identification and stored setup parameters. A switching regulator is used to step down system +12 volts power to +6 volts for powering the IR source and the detector Peltier cooler. All circuitry adjustments are made via the microprocessor-controlled digital potentiometers

Flow Control PCA. The pressure/flow portion of the board contains an absolute and a gauge pressure transducer to measure cell pressure and control sample flow. This board also controls the pump speed, powers the chassis fan and has a heater control circuit to heat the flow block. (A series only).

Preamp/pressure board. The pressure/flow portion of the board contains an absolute and a gauge pressure transducer to measure cell pressure and detect sample flow. This board also powers the chassis fan. (B series only).

2.2 Operation Modes

The analyzer operates in a number of different measurement modes. These modes include startup, measurement, and auto-zero modes. Following is a description of each of the operating modes.

2.2.1 Startup Mode

When the instrument is initially powered up, several components in the instrument are automatically configured by the microprocessor and an automatic zero is run. This process typically takes about 10 minutes. Following is a description of the various adjustments made during the startup routine. All adjustments are automatically performed by the microprocessor; no manual intervention is required. During all the startup routines the cell is filled with zero air.

2.2.1.1 Reference Self Test

The test reference and input potentiometers on the preprocessor are adjusted to ensure response of the reference channel of the preprocessor.

2.2.1.2 Electronic Zero Test

The test measure potentiometer on the preprocessor board is adjusted to ensure response of the measurement channel of the preprocessor.

2.2.1.3 Reference Adjust

Reference adjust allows the input pot of the preprocessor to be adjusted for the proper reference voltage level of 4.0 ± 0.1 volts. (The reference voltage is proportional to the intensity of the IR signal.)

2.2.1.4 Electronic Zero Adjust

Electronic zero adjust sets the preprocessor measurement channel to minimize any electronic or optical offset present at zero. First the cell is allowed to fill completely with zero air. The preprocessor measure coarse zero and measure fine zero potentiometers are then adjusted until a concentration voltage of just above 0.00 volts is obtained. This is the analyzer’s coarse zero adjustment. Once this is set it is not readjusted until another automatic startup routine is performed or the concentration voltage is sensed to be below -0.1 volts.

2.2.1.5 Background

Background allows the analyzer to sample zero air and measure the level of the concentration voltage. This reading is taken as the zero signal level and this is subtracted from any subsequent readings. This is the analyzer’s fine zero measurement. The background is re-run nightly at midnight (unless background is disabled), when manually selected through the `CALIBRATION MENU`, when a temperature change of greater than 4° C is sensed, or when another automatic startup routine is performed.

2.2.1.6 Sample Fill/Measure

After the background the analyzer is switched into the sample fill mode where the reaction cell is filled with sample gas, and finally to sample measure mode when actual gas measurement begins.

2.2.1.7 Quick-Start Routine

If the analyzer power is removed for less than two minutes, the full automatic startup routine is replaced by a quick start routine. The analyzer is returned to its last known operating parameters and normal operation is immediately restored. This allows the analyzer to rapidly return to measurement mode and keeps data

loss to a minimum. If power is lost for greater than two minutes, a full automatic restart is performed.

2.2.2 Measure Modes

2.2.2.1 Sample Measure

Sample measure is the standard operating mode of the EC9832. The cell is continuously filled with sample gas via the main valve manifold. The IR detector senses the IR signal from the measurement cell. This signal is amplified, and conditioned by the preprocessor to separate reference and measure signals, which are compared to become what is called the concentration voltage. This concentration voltage is then used to determine gas concentrations.

2.2.2.2 Zero Measure

Zero measure allows the cell to be filled with zero air either from the internal zero air source with internal valves selected or from an external zero air source with external valves selected. Processing of the signal is identical to measurement processing, the only difference is the source of the sample stream.

2.2.2.3 Span Measure

Span measure allows the cell to be filled with gas from an external span source. Processing of the signal is identical to measurement processing, the only difference is the source of the sample stream.

2.2.2.4 AZS Cycle

The analyzer can be placed in an AZS cycle mode where the sample stream is automatically switched to zero, then span, then back to sample. Further information on the AZS cycles is included in the *EC9832 Operation Manual*.

2.2.3 Auto Zero Routines

The EC9832 is an auto-zero instrument. The analyzer is allowed to periodically sample zero air and correct for the readings obtained.

2.2.3.1 Background

The auto-zero function (background) is performed nightly at midnight unless `BACKGROUND` is `DISABLED`. This compensates for drift in the measurement baseline of the analyzer. The nightly background routine is identical to the background described in the startup routine.

2.2.3.2 Electronic Zero Adjust

Long-term negative drift may occasionally cause the measurement voltage near zero to drift outside the range of the preprocessor measurement channel. If this occurs, the analyzer will initiate an electronic zero adjust to reset the preprocessor measurement coarse and fine zero adjustment. This routine is identical to the electronic zero adjust described in the startup routine. After an electronic zero adjust, the analyzer will perform a background to incorporate this new baseline value.

3.0 Maintenance

3.1 Maintenance Schedule

The following outlines a periodic maintenance schedule for the EC9832 analyzer. This schedule is based on experience under normal operating conditions, and may need to be modified to suit specific operating conditions and regulations. It is recommended that this schedule be followed in order to maintain reliable, long-term operation of the analyzer.

Interval[1]	Item	Procedure	Section
Weekly	Inlet Particulate Filter	Check/Replace	Service Manual:- 3.3.1
	Event Log / System Faults	Check	Service Manual:- 4.2.4 & 4.2.7
	Precision Check	Check	Operation Manual:- 2.4
Monthly	Fan Filter	Check/Clean	Service Manual:- 3.3.3
	Zero / Span Calibration	Perform	Operation Manual:- 2.4
	Clock	Check	Operation Manual:-2.3.3
6 Monthly	CO-CO_2 Converter	Check/Replace	Service Manual:- 3.3.6
	Multi-point Calibration	Perform	Operation Manual:- 3.2
1 Year	DFU Filter	Replace	Service Manual:- 3.3.4
	Sintered Filter (B series)	Replace	Service Manual:- 3.3.5
	Detector Signal	Adjust	Service Manual:- 3.3.7
	Leak Check	Perform	Service Manual:- 3.3.10
	Flow Calibration	Check / Calibrate	Service Manual:- 3.5

[1] Suggested intervals for normal operation and actual intervals will vary depending upon application. The user can refer to this table as a guideline, but should develop a maintenance schedule to suit their specific requirements.

3.2 Replaceable Parts

EC9832 Analyzer Spare Parts Requirements			
Description	**Series**	**Part Number**	**Level**
O-ring, orifice and filter	B	25000447-007	1
Filter element, 5 micron, consumable (50 each)	A & B	98000098-1	1
Filter, sintered	B	98000181-1	1
Infrared source	A & B	80340371	2
CO to CO_2 converter assembly	A & B	98300023	2
Filter, optical	A & B	002-057401	3
O-ring, optical filter	A & B	025-030410	3
O-ring, sapphire window	A & B	28000186	3
Extraction tool, minifit connectors	A & B	29000141-2	3
Detector	A & B	37000076	3
Pump	A	58500037	3
Window, sapphire	A & B	883-051600	3
PCA, Voltage Regulator	A & B	98000056	3
Display/switch assembly	A & B	98000057SP	3
PCA, Microprocessor (SMD)	A & B	98000063-4	3
PCA, 50-Pin I/O	A	98000066-2	3
Power supply, 115/230 VAC to 12 VDC	A & B	98000142	3
Orifice, 14 mil	B	98000180-13	3
Extraction tool, filter and orifice	B	98000190	3
Service kit, pump	B	98000242	3
Flow/pressure assembly	B	98107012-2SP	3
Flow control assembly	A	98300046SP3	3
PCA USB Board Assembly	A & B	98007502	3
PCA, Preprocessor	A & B	98300003	3
Preamplifier/detector assembly	A & B	98300015	3
Motor, correlation wheel	A & B	98300032	3
Reflector, optical interrupter	A & B	98300033	3
Valve manifold assembly	A & B	98300037-2	3
Source timing assembly	A & B	98300049	3
Heater/thermistor assembly	A & B	98300061	3
Correlation wheel assembly	A & B	98300084	3

Level 1: General maintenance supplies and expendables such as filters, O-rings, lamps, etc.

Level 2: Critical items that are known from experience to have a higher failure rate, such as pumps, heaters, converters, valves, and circuit boards.

Level 3: Other miscellaneous items not included in Level 1 or 2. This level includes other spare parts that are not expected to fail over a given time frame.

Components marked with shading are essential components which need to be kept on hand at all times.

EC9832 Analyzer Spare Parts Requirements Options and Accessories		
Description	**Series**	**Part Number**
Pump, external, 115V/60 Hz, 4 slpm at 20 inches Hg	B	884-017300
Pump, external, 110V/50 Hz, 4 slpm at 20 inches Hg	B	884-017301
Pump, external, 230V/50 Hz, 4 slpm at 20 inches Hg	B	884-017302
Pump, external, 110V/50 Hz, 4 slpm at 20 inches Hg	B	884-017303
Rack mount kit with slides	A & B	98000036-2
PCA, 50-Pin I/O	B	98000066-2
Battery power option, 12 VDC	A & B	98000115
Filter, particulate, sample inlet, 5 micron	B	98000210-1
Filter kit, particulate, sample inlet, 5 micron	A	98000211-1
50-pin connector and shell kit	A & B	98000235-1
Valve manifold kit, external zero/span (EZS)	A & B	98300087
Valve, span, for external pressurized span source or gas cylinder	A & B	98301002
EC9832 Operation Manual	A & B	98307600
EC9832 Service Manual	A & B	98307601

3.2.1 Expected Life Span of Consumables

Component	Minimum	Typical
IR Source (98300049)	6 months	2 years
CO-CO_2 Converter (98300023)	1 year	3 years

3.3 Maintenance Procedures

Following is a list of routine maintenance procedures which may be required over the life of the analyzer.

<u>Recommended equipment to perform maintenance:</u>

Toolbox
Oscilloscope
Digital multimeter (DMM)
Computer or remote data terminal and connection cable for RS232 communication
Pressure transducer (absolute) and connection tubing, calibrated in torr
Flowmeter (2 slpm nominal)
Wire strippers
Soldering iron
Minifit extraction tool
Orifice removal tool
Assortment of 1/4” and 1/8” tubing and fittings
Test zero air source (CO-free)
Test span gas source
Leak tester.

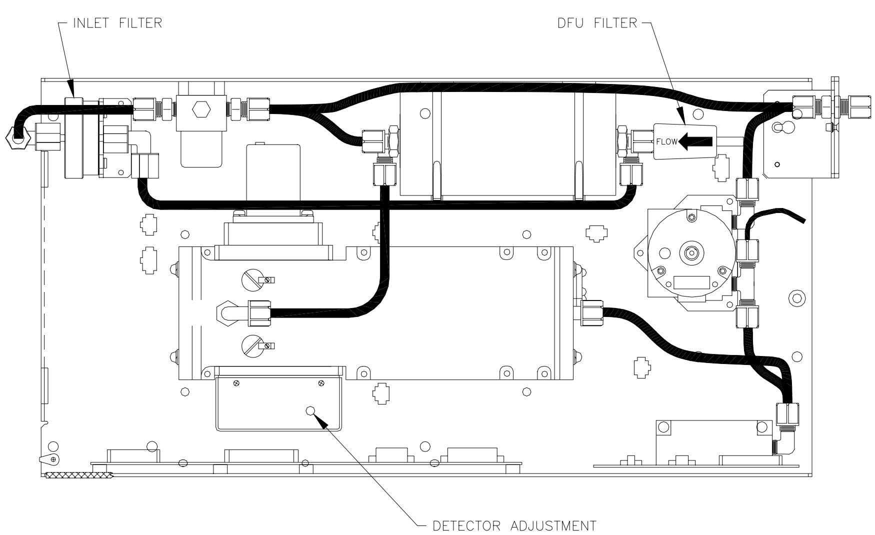


Figure 12. Routine Maintenance Components (A Series)

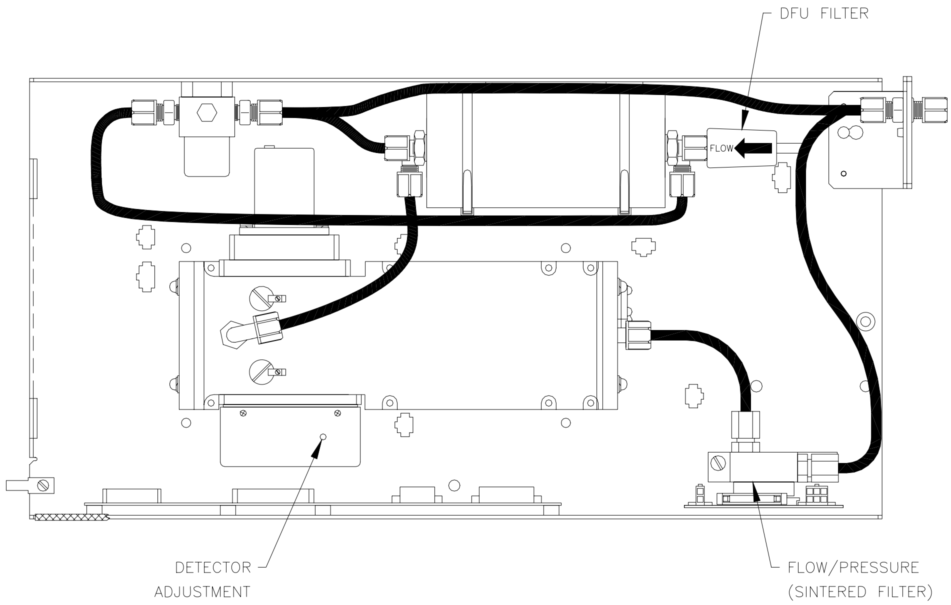


Figure 13. Routine Maintenance Components (B Series)

3.3.1 Check Particulate Filter

The inlet filter prevents particulates from entering the pneumatic components of the EC9832. Contamination of the filter can result in degraded performance of the EC9832, including slow response time, erroneous readings, temperature drift, and various other problems.

Several factors affect the filter replacement schedule. In the springtime, for example, pollens and dust might accumulate in the filter. Man-made environmental changes such as construction dust might indicate more frequent change, or a climate where dry, dusty conditions are normal might dictate more frequent filter replacement than climates with few natural pollutants.

Determining the schedule for changing the filter is best developed by monitoring the filter at weekly intervals for the first few months, then adapting the schedule to fit the specific site.

3.3.2 Particulate Filter Replacement Procedure

Use Figure 14 as reference when performing the filter replacement procedure.

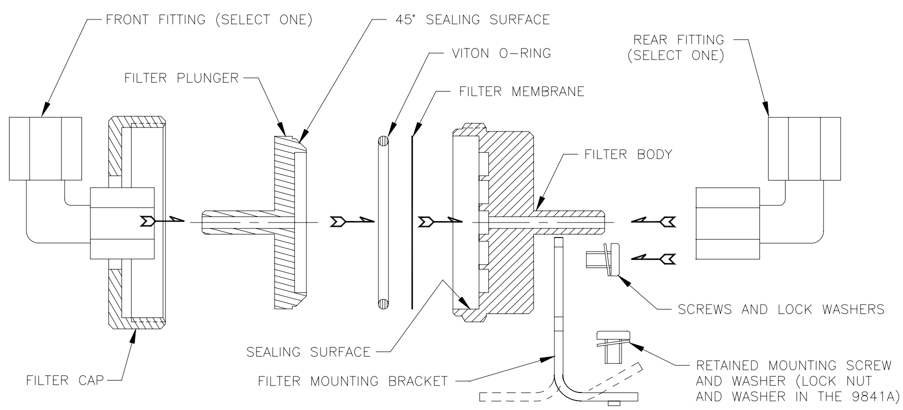


Figure 14. Filter Replacement Procedure

1. Open the front panel to access the service switches and particulate filter. Position the Pump switch in the secondary front panel to OFF. For the B series Analyzer, you will need to disconnect the external pump.

2. Completely unthread the filter cap by turning it counterclockwise.

3. Pull the filter plunger out of the body, carefully resting it in a secure place. The O-ring and filter membrane are now exposed inside the filter body.

4. Remove, inspect, and wipe down the O-ring. Replace the O-ring only if damaged.

5. Remove, discard, and replace the old filter membrane.

6. Reinstall the O-ring over the new membrane, reinstall the plunger, and **hand-thread** the cap back into place by turning it clockwise. Do not use tools.

7. Return the Pump to ON.

8. Close the front panel.

3.3.3 Clean Fan Filter

The fan filter is located on the rear of the analyzer. If this filter becomes contaminated with dust and dirt, it may affect the cooling capacity of the analyzer.

The fan screen should be cleaned by removing it from the analyzer and blowing it out with compressed air, or by cleaning it with mild soapy water and air drying.

3.3.4 DFU Replacement

The zero air entering the CO-CO_2 converter is filtered by a disposable filtration unit (DFU) to prevent contamination of the pneumatics and measurement cell. Failure of the DFU could result in poor zero readings or cell contamination. This filter is located inside the analyzer connected to the rear of the CO-CO_2 converter. To replace the filter:

1. Turn off the pump.
2. Remove and retain the Kynar nut from the end of the DFU.
3. Remove and replace the DFU, ensuring that the direction of flow is correct.
4. Reinstall the Kynar nut, ensuring that the ferrules are properly installed in the nut.
5. Turn on the pump.

3.3.5 Sintered Filter/Orifice Replacement (B Series)

The sintered filter is used as a final filter to prevent contamination and blockage of the sample orifice. If the filter becomes plugged, the result is loss of sample flow through the analyzer. Typically, replacement of the sintered filter alone will be sufficient to maintain operation, but occasionally the orifices should be checked and cleaned to ensure proper operation.

Required equipment:
Orifice/filter removal tool (P/N 98000190)

1. Turn off the pump.
2. Disconnect the pneumatic and electrical connections from the flow/pressure assembly and remove the block from the analyzer. Refer to Figure 13.
3. The sintered filter is located in the inlet fitting of the flow block (refer to Figure 15). Remove this fitting and replace the filter (be sure to use a new O-ring). Reinstall the fitting into the block, ensuring that the O-ring is in place around the base of the fitting.

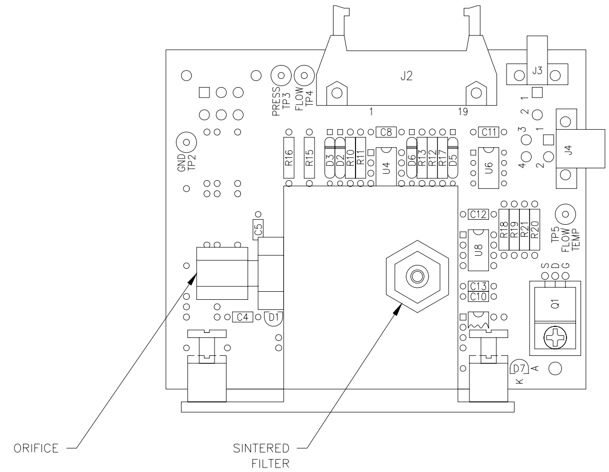


Figure 15. Sintered Filter Replacement

4. The sample orifice is located in the outlet fitting of the flow block. ***If desired***, remove this fitting and replace the orifice (be sure to use a new O-ring). Reinstall the fitting into the block, ensuring that the O-ring is in place around the base of the fitting.

5. Reinstall the flow/pressure assembly into the analyzer and reconnect the pneumatic and electrical connections.

6. Turn on the pump.

3.3.6 CO-CO_2 Converter Check

The internal CO-CO_2 converter provides a source of continuous zero air for auto-zero and background functions of the EC9832. Failure of the converter can result in drift, poor sensitivity near zero, and continuous electronic zero adjusts. To check the CO-CO_2 converter:

Required equipment:
Test zero air supply

1. From the `CALIBRATION MENU` place the analyzer in `CAL. MODE: ZERO`. This will allow the analyzer to sample zero air from the zero air scrubber. Allow sampling for approximately 5 minutes.

2. Record the front panel CO reading as the initial value.

Note

This value should be 0.00 ±0.1 ppm. If it is not, a background should be initiated by choosing `CALIBRATION MENU/BACKGROUND: START` and pressing enter to re-establish the zero baseline. The background will take approximately 5 minutes to complete.

3. Connect the challenge zero air to the Sample inlet of the analyzer. Be sure the inlet pressure is maintained at ambient pressure.

4. From the `CALIBRATION MENU` select `CAL. MODE: MEASURE` and press <Enter>. This will allow the analyzer to sample the challenge zero air. Allow sampling for 5 minutes.

5. Record the front panel CO reading as the challenge value.

6. Compare the CO initial value and the challenge value. They should agree within ±0.2 ppm. If the initial value is more positive than the challenge value, the CO-CO_2 converter should be replaced.

7. Disconnect the challenge zero air and reconnect the sample line to the Sample inlet of the analyzer. Verify that the analyzer is in the `SAMPLE MEASURE` mode.

3.3.7 Detector Signal Adjustment

The detector signal must be maintained at proper intensity to ensure satisfactory operation of the analyzer. If this signal becomes too large or too weak, the analyzer will not be able to maintain proper reference and measurement signals, resulting in loss of measurement capability. To perform the detector signal adjustment:

Caution

If the detector signal is adjusted, the analyzer will require recalibration.

Required equipment:
Oscilloscope

1. Remove the analyzer cover and connect an oscilloscope to the PAMP2VPP test point (J5-14) on the Preprocessor PCA. Set the scope for 0.5 v/div and 2 msec/div. Synchronize the scope using the REF test point (J5-3) on the Preprocessor PCA.

2. The detector adjustment potentiometer is accessible through the hole on the top of the detector cover. Use an electronic *tweeker* to adjust the preamp signal using for 2 volts peak-to-peak on the smaller signal (refer to Figure 16).

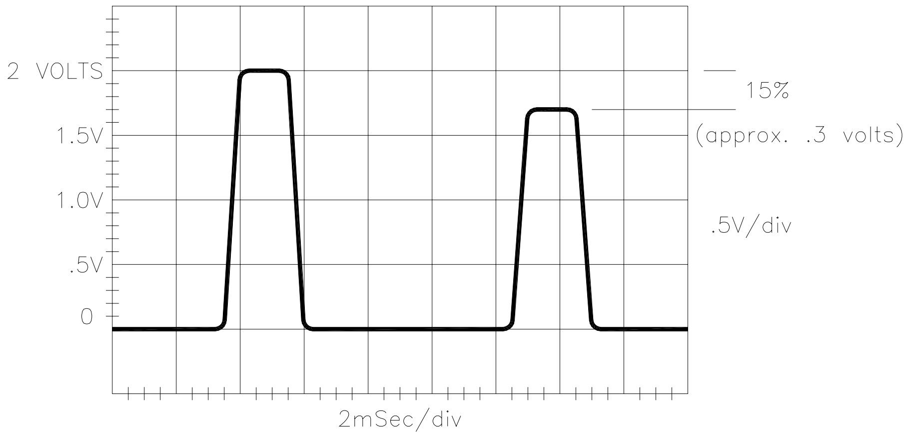


Figure 16. Detector Signal Adjustment

3. Verify that the two signals on the detector signal differ in amplitude by approximately 15% (refer to Figure 16). If they differ by less than 15%, the correlation wheel may require replacement.

4. Disconnect the oscilloscope and reinstall the cover. If the signal was readjusted, the analyzer should be reset and recalibrated after its startup sequence is complete.

3.3.8 Correlation Wheel/Motor/IR Source Replacement

Refer to Figure 17.

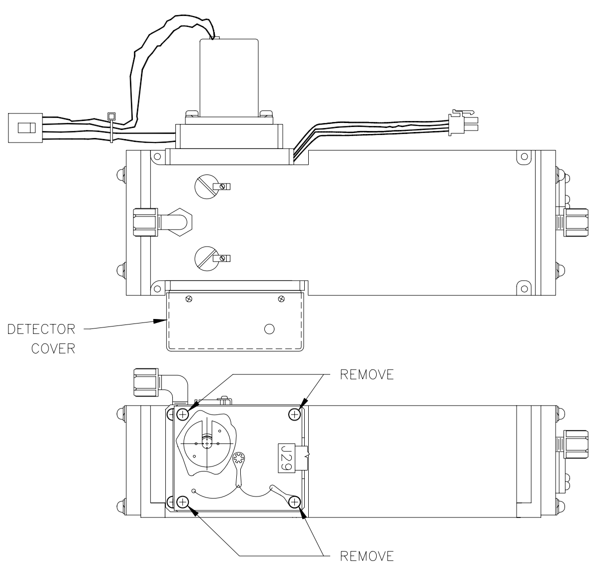


Figure 17. Correlation Wheel/Motor/IR Source Replacement

1. Turn the analyzer off and disconnect power.
2. Disconnect the 1/4” tubing from the measurement cell inlet and outlet and all electrical connections from the bench to the sensor tub. Remove the four mounting screws from the bench and remove the bench from the sensor tub.
3. Remove the four screws securing the source/timing assembly to the optical bench and remove the block from the bench.
4. Remove the correlation wheel by loosening the set screw in the side of the wheel body (0.5 mm hex screw). Slide the correlation wheel off of the motor shaft.
5. Remove the four screws securing the motor to the mounting plate and remove the motor.
6. Remove the two screws that fasten the IR source into the source block. Remove the IR source from the block.
7. Using a minifit extraction tool, remove the two wires from the source to the electrical connection. Remove the IR source and install the new source, rewiring the new source in place of the old one.
8. Reinstall the IR source.
9. Reinstall the motor.
10. Reinstall the correlation wheel. When securing the correlation wheel to the motor shaft, ensure the set screw secures to the flat face of the motor shaft.
11. Reassemble the source/timing assembly to the optical bench and reinstall the bench in the sensor tub.
12. Perform the detector adjustment from earlier in this section. Be sure to recalibrate the analyzer.

3.3.9 IR Detector Replacement

Refer to Figure 18.

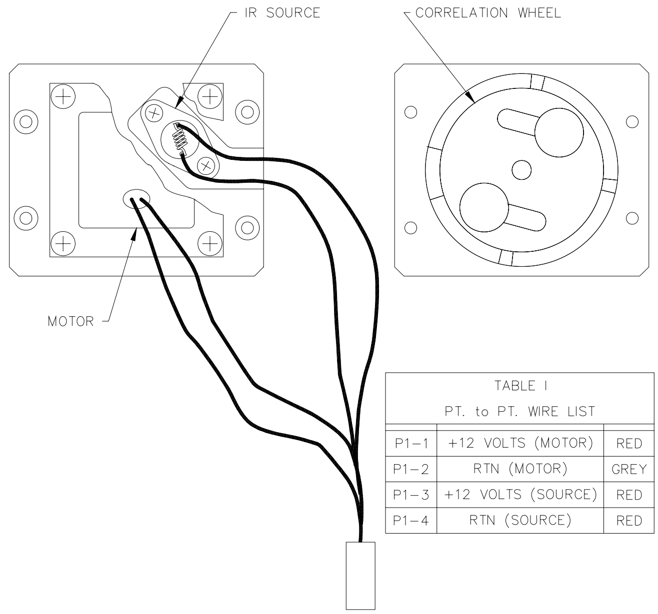


TABLE I PT. to PT. WIRE LIST		
P1–1	+12 VOLTS (MOTOR)	RED
P1–2	RTN (MOTOR)	GREY
P1–3	+12 VOLTS (SOURCE)	RED
P1–4	RTN (SOURCE)	RED

Figure 18. IR Detector Replacement

1. Turn the analyzer off and disconnect power.

2. Disconnect the 1/4” tubing from the measurement cell inlet and outlet and all electrical connections from the bench to the sensor tub. Remove the four mounting screws from the bench and remove the bench from the sensor tub.

3. Remove the four screws securing the detector cover to the detector assembly.

4. Remove the four screws securing the detector assembly to the bench.

5. Remove the detector assembly. Install the new detector in reverse order of the above steps.

3.3.10 Leak Test Procedure

3.3.10.1 A Series

This is a test for the pneumatic system of the instrument. The display readings will indicate whether the system is leaking.

> **NOTE**: This procedure applies ***only to the instrument***. It does not include the EZS valve option. The option, if included in the instrument, must be disabled to perform this test.

1. Enter the `TEST MENU` and select `OUTPUT TEST MENU`, then `VALVE TEST MENU`; from these items pick `VALVE SEQUENCING` and set to `OFF`.

2. Set all valves to CLOSED.

3. Press <Pg Up> to return to the OUTPUT TEST MENU and choose FLOW CONTROL POTS.

4. Turn the Pump Switch on the secondary panel to OFF and verify FLOW: 0.00 SLPM. If it does not read 0.00 the Flow Control PCA requires recalibration. Return the Pump Switch to ON.

5. Plug the inlet and auxiliary ports on the rear panel. Also plug the top rear of the CO to CO_2 converter, located behind the valve assembly.

6. Verify GAS FLOW in the FLOW CONTROL POTS screen reads 0.00. If the reading is not 0.00, the leak is somewhere between the valves and the flow block.

7. Press <Pg Up> and select the VALVE TEST MENU. Set INT. VALVE #1 to OPEN; return to the FLOW CONTROL POTS screen and verify GAS FLOW reads 0.00 SLPM. If the reading is not zero, the leak is in the measure/sample line.

8. Return to the VALVE TEST MENU. Close the INT. VALVE #1 and open the INT. VALVE #2. Return to the FLOW CONTROL POTS screen and observe the flow reading. If the reading is not zero, the leak is in the zero air line.

9. Return to the VALVE TEST MENU. Close the INT. VALVE #2 and open the INT. VALVE #3. Return to the FLOW CONTROL POTS screen and observe the GAS FLOW. If the reading is not zero, the leak is in the span gas line.

10. Return to the VALVE TEST MENU. Close INT. VALVE #3 and open INT. VALVE #1 for normal operation.

11. Set VALVE SEQUENCING to ON and then press <Exit>. Remove the plugs from the inlet and auxiliary ports and from the CO to CO_2 converter port.

12. Verify that the flow returns to the original setting by observing the INSTRUMENT STATUS menu.

The actual flow through the analyzer should be checked by turning on the pump and connecting a flow meter to the measure inlet (ensure that the analyzer is in SAMPLE MEASURE). Actual flow through the analyzer should be approximately 1 slpm. If flow is too low, perform the flow calibration in section 3.5 below.

3.3.10.2 B Series

The leak check ensures the integrity of the pneumatic system, and should be performed annually or after any maintenance on the pneumatic system. To leak check the EC9832B, perform steps 1 through 6 below.

Note

This leak check procedure requires that the vacuum capacity of the pump be known and converted to an equivalent atmospheric pressure. This can be obtained by connecting a vacuum gauge through a tee to the pump inlet.

1. Disconnect the inlet line from the Sample inlet. Leave the Exhaust port connected to the pump.

2. Turn off the pump and allow to settle for 2 minutes. Select the `INSTRUMENT STATUS` menu and record the `GAS PRESSURE` reading as the current ambient pressure.

3. Plug the Sample inlet port.

4. Turn on the pump and allow it to operate for 5 minutes to evacuate the pneumatics.

5. Select the `INSTRUMENT STATUS` menu and monitor the `GAS FLOW` and `GAS PRESSURE` readings. After 5 minutes, the `GAS FLOW` should indicate 0.00 slpm and the `GAS PRESSURE` should be equal to the ambient pressure - vacuum capacity of the pump ±15 torr (2 kPa) (see following conversion).

Note

To convert vacuum capacity to equivalent atmospheric pressure perform the following calculation:

Current ambient pressure (torr) - (Vacuum (“Hg) * 25.32) Or Current ambient pressure (kPa) - Vacuum (kPa)

6. Unplug the Sample port and reconnect the sample line.

If a leak is detected, attempt to isolate the leak by using the `VALVE TEST MENU` and the pneumatic diagram to select and close off different sections of the analyzer.

Caution

Do *not* use pressure to isolate leaks. Pressure in excess of 5 psi will damage the pressure transducers.

The actual flow through the analyzer should be checked by turning on the exhaust pump and connecting a flowmeter to the Measure inlet (ensure that the analyzer is in `SAMPLE MEASURE`). Actual flow through the analyzer should be approximately 1 slpm. If flow is too low, perform the sintered filter replacement procedure in section 3.3.5. If flow is too high, there is probably a leak around the sintered filter or orifice.

3.4 Hidden Menu

The new software features of the Ecotech Microprocessor board (SMD version), provides provisions for a hidden menu. This enables the experienced user to access menus for maintenance purposes. These menus eliminate the need for a portable computer to perform flow & pressure calibrations.

To access the hidden menu, simultaneously press three keys on the front panel from the primary screen as follows:

Up arrow (⮝) , <Pg Up> and *Enter*> (↵)
The following menu will be displayed:

```
                    HIDDEN MENU

       SERIES                       A
       ANALYZER TYPE             9832
       SUB TYPE              STANDARD
       FLOW BLOCK TYPE       STANDARD

       PRESSURE CALIBRATION MENU
       FLOW CALIBRATION MENU
```

Figure 19. Hidden Menu

SERIES

Allows the user to choose the correct series of analyser. The options are `A, B & S.` The selection must reflect the Hardware to which it is being installed. i.e. for a EC9832 analyser, it must be set to `A,` and for a EC9832B analyser set to `B,` in order to operate correctly. The `S` option is reserved for special system software.

ANALYSER TYPE

Allows the user to choose the correct analyser type. The options are `9810, 9811, 9812, 9820, 9832, 9841, 9842 & 9850.` The selection must reflect the

Hardware to which it is being installed. i.e. for a EC9832 analyser, it must be set to `9832` in order to operate correctly. The analyser type will default to `????` if the device type has not been set or cannot be read from the preprocessor board.

SUB TYPE
Allows the user to set the correct Hardware options for this analyzer. The options for the EC9832 A & B series are: `STANDARD, TRACE & HIGH LVL.`

FLOW BLOCK TYPE
Displays the type of flow block installed. If the flow block is not connected or calibrated, then no type will be displayed. For **A** series analyzers the **STANDARD** type is selected. For **B** series analyzers the **ISO-B** type is selected. The `PRESSURE and FLOW CALIBRATION MENU's` will change depending on which `FLOW BLOCK TYPE` is selected.

3.4.1 Pressure & Flow Calibration sub-menus

The pressure and flow calibration menus allow the user to manually calibrate the pressure transducers and calibrate the flow of the flow controllers. The contents of the pressure and flow calibration menus are described below. Note that these parameters will vary depending on which flow block type is selected. Refer to section 3.5 for further details.

CRITICAL ORIFICE
Designated flow rate of the critical orifice installed in the ISO-B flow block. For the EC9832B, this should be set to 1.000 unless otherwise specified.

DESIRED FLOW
Desired flow rate that the standard flow block will maintain a constant flow at.

FLOW SPAN POINT
During the flow calibration of the standard flow block, this is where the externally measured flow rate is entered.

FLOW ZERO POINT
During the zero flow calibration of the standard flow block, this option must be set to `set` and enter pressed for the zero calibration to take effect. Select `cancel` to abort this operation.

FLOW TRANSDUCER DF
Selecting set, loads the factory default calibration curve into the earom on the standard flow control board.

PRESSURE 1 HIGH
Pressure entered during ambient calibration.

PRESSURE 1 LOW
Pressure entered during low pressure calibration.

VALVE SEQUENCING
Turn the valve sequencing on or off. Same as in the Valve Test Menu. When turned off, the appropriate valve sequence will set ready for pressure calibration.

CONTROL LOOP
When `ENABLED`, the microprocessor controls the pump speed (via the flow control pots) to give the desired flow rate. When `DISSABLED`, the user can manually adjust the pump speed using the flow control pots. For the standard flow block only.

FLOW CONTROL ZERO
This flow control pot is used to manually adjust the zero flow offset voltage during the zero calibration of the standard flow block.

PUMP SPEED COARSE/ FINE
The two flow control pots (`PUMP SPEED COARSE & PUMP SPEED FINE`) are software-controlled pots which control the pumps speed on the standard flow block.

AMBIENT PRESSURE
Current ambient pressure measured from the ISO flow controller.

GAS PRESSURE
Current gas pressure measured from the flow controller.

GAS FLOW
Current gas flow measured from the flow controller.

3.5 Pressure & Flow Calibration

The pressure and flow calibrations should be performed whenever a flow or pressure reading becomes suspect, when a transducer is replaced, or can be performed as an annual maintenance item. The pressure and flow transducer calibration may be performed separately or together. The following procedures cover both the `STANDARD` and `ISO-B` flow block types. For both procedures the following equipment is required:

- Digital Volt Meter.
- Pressure transducer (absolute); calibrated in torr.
- Flowmeter, 1 slpm nominal
- ¼” fitting with hose to suit pressure transducer.

3.5.1 Pressure/Flow Calibration (A Series)

3.5.1.1 Setup

Note: The EC9832 analyzer should be left running for at least one hour with the pump switched on before this procedure is attempted. This will allow the flow block temperature to stabilise to 50°C.

From the `HIDDEN MENU`, set the **`FLOW BLOCK TYPE`** `TO` **`STANDARD`**, and press Enter> (↵). Press Reset on the analyzer secondary panel.

3.5.1.2 Pressure Calibration

1. From the `HIDDEN MENU`, select the **`PRESSURE CALIBRATION MENU`**. The menu of Figure 20 should be displayed.

```
PRESSURE CALIBRATION MENU

PRESSURE 1 HIGH       743.0 TORR
PRESSURE 1 LOW        530.0 TORR

VALVE SEQUENCING      ON
CONTROL LOOP          ENABLED
PUMP SPEED COARSE     28

GAS PRESSURE          710.0 TORR
GAS FLOW              1.000 SLPM
```

Figure 20. Pressure Calibration Menu for Standard flow block

2. Verify the pump is turned off by setting the pump switch to **OFF** on the secondary panel.

3. Allow 30 seconds for the pressure reading to stabilise to ambient pressure on both the calibrated pressure transducer and the analyzer. This reading (in TORR) should be the ambient pressure. Set this value as **`PRESSURE 1 HIGH`** in the `PRESSURE CALIBRATION MENU` and then press Enter> (↵).

   Note: to convert from millibar to TORR, multiply the pressure by 0.75.

4. Set the **`CONTROL LOOP`** `TO` **`DISABLED`**, and press Enter> (↵).This will disable the flow control loop.

5. Connect the calibrated pressure transducer to the sample inlet on the rear panel of the analyzer.

6. Turn the pump **ON** from the secondary panel.

7. Set the **PUMP SPEED COARSE** to **99** and press Enter> (↵).

8. Allow approximately 1 minute for the pressure to drop to a stable reading. This reading should be typically 100 to 200 torr lower than the ambient pressure (depending upon the capacity of the pump).

9. Set this reading (in TORR) as **PRESSURE 1 LOW** in the PRESSURE CALIBRATION MENU and press Enter> (↵).

10. Disconnect the pressure transducer from the inlet and turn the pump **OFF**.

11. To verify that the pressure transducers on the standard flow control board are calibrated, view the **GAS PRESSURE** reading in the PRESSURE CALIBRATION MENU . it should be at ambient pressure +/- 2 TORR.

This completes the pressure transducer calibration procedure.

3.5.1.3 Flow Calibration

1. From the HIDDEN MENU, select the **FLOW CALIBRATION MENU**. The menu of Figure 21 should be displayed.

```
              FLOW CALIBRATION MENU

DESIRED FLOW           1.00 SLPM
FLOW CONTROL ZERO      81
FLOW TRANSDUCER DF     CANCEL
CONTROL LOOP           ENABLED
VALVE SEQUENCING       ON
FLOW ZERO POINT        CANCEL
FLOW SPAN POINT        1.000 SLPM
PUMP SPEED COARSE      28
PUMP SPEED FINE        7
GAS PRESSURE           710.0 TORR
GAS FLOW               1.000 SLPM
```

Figure 21. Flow Calibration Menu for Standard flow block

2. Verify the pump is turned **OFF** .and the **CONTROL LOOP** is **DISABLED** in the FLOW CALIBRATION MENU.

3. Load the linearization table into the flow control board EAROM by setting **FLOW TRANSDUCER DF** to **SET** and pressing Enter> (↵). The linearization table contains the following parameters:

   Flow points: 0, 0.5, 1.75, 2.5, 3.25, 3.75.

Voltage points: 0,0.13, 0.91, 1.783, 2.5, 3.478.

4. Connect the calibrated flow meter to the sample inlet on the rear panel of the analyzer. With the pump turned off, verify that there is no flow.

5. Connect a Digital Volt Meter (DVM) to the FLOW test point on the Flow Control PCA. TP1 is the 0V connection, and pin 5 of the J2 connector is the FLOW test point. The Digital Volt Meter should be set to the 2V DC range.

6. Adjust the **FLOW CONTROL ZERO** pot until the DVM reads slightly positive (0 to 0.5 VDC), then press <Enter>.

7. Set the **FLOW ZERO POINT** to **SET** and press Enter> (↵). The **GAS FLOW** should now read 0.000 SLPM.

8. Disconnect the DVM.

9. Turn the analyzer pump **ON** and verify the **CONTROL LOOP** is still **DISABLED.**

10. From FLOW CALIBRATION MENU use the **PUMP SPEED COARSE** and **PUMP SPEED FINE** pots to adjust the measured flow (external flowmeter) to as close as possible to 0.50 SLPM.

Note

If the analyzer attempts to automatically change the pot position during adjustment then repeat step 9.

11. Record the average measured flow from the flowmeter and enter it into the **FLOW SPAN POINT** and press Enter> (↵).

12. Set the **DESIRED FLOW** to 1.50 SLPM and press Enter> (↵).

13. Press Reset on the analyzer and allow the flow to stabilize. Verify the flowmeter reading is now 1.50 ±0.15 SLPM.

Note

After the instrument startup is complete, verify the gas pressure is slightly below actual ambient pressure (approximately 10 - 20 torr). The gas pressure and gas flow readings may not bet updated during the startup routine.

This completes the flow transducer calibration procedure.

3.5.2 Pressure/Flow Calibration (B Series)

3.5.2.1 Setup

Note: The EC9832B analyzer should be left running for at least one hour with the pump running before this procedure is attempted. This will allow the flow block temperature to stabilise to 50°C.

From the `HIDDEN MENU`, set the **`FLOW BLOCK TYPE`** `TO` **`ISO-B`**, and press Enter> (↵). Press Reset on the analyzer secondary panel.

3.5.2.2 Pressure Calibration

1. From the `HIDDEN MENU`, select the **`PRESSURE CALIBRATION MENU`**. The menu of Figure 22 should be displayed.

```
              PRESSURE CALIBRATION MENU


       PRESSURE 1 HIGH      743.0 TORR
       PRESSURE 1 LOW       70.0 TORR

       VALVE SEQUENCING     ON



       AMBIENT PRESSURE     750.0 TORR
       GAS PRESSURE         710.0 TORR
       GAS FLOW             1.500 SLPM
```

Figure 22. Pressure Calibration Menu for ISO-B Flow Block

2. Turn off the pump.

3. Disconnect the inlet tubing from the flow block and connect a calibrated pressure transducer to this inlet.

4. Allow 30 seconds for the pressure reading to stabilise to ambient pressure on both the calibrated pressure transducer and the analyzer. This reading (in TORR) should be the ambient pressure. Set this value as **`PRESSURE 1 HIGH`** in the `PRESSURE CALIBRATION MENU` and press Enter> (↵).

   Note: to convert from millibar to TORR, multiply the pressure by 0.75.

5. Connect the pump to the exhaust port and turn it on.

6. Allow the pump to evacuate the cell and the pressure reading to stabilize. This reading should be low (typically 100 to 200 torr), and is dependent upon the capacity of the pump. Set this value as **PRESSURE 1 LOW** in the PRESSURE CALIBRATION MENU and press Enter> (↵).

7. Disconnect the pressure transducer from the flow control inlet and reconnect the inlet tubing.

The flow calibration must now be completed.

3.5.2.3 Flow Calibration

1. From the HIDDEN MENU, select the **FLOW CALIBRATION MENU**. The menu of Figure 23 should be displayed.

```
                 FLOW CALIBRATION MENU

              CRITICAL ORIFICE     1.080

              VALVE SEQUENCING     ON


              AMBIENT PRESSURE     750.0 TORR
              GAS PRESSURE         710.0 TORR
              GAS FLOW             1.500 SLPM
```

Figure 23. Flow Calibration Menu for ISO-B flow block

2. Set the **CRITICAL ORIFICE** to **1.500** and press Enter> (↵).

3. Press Reset on the analyzer secondary panel.

4. The actual flow should now be checked by turning on the pump and connecting a flow meter to the sample inlet of the analyzer. The flow should read approximately 1.0 slpm. If the flow is too low, perform the sintered filter/orifice replacement procedure. If flow is too high, there is probably a leak.

Note

The gas pressure and gas flow readings on the INSTRUMENT STATUS menu will not update until the startup routine is complete.

This completes the pressure & flow transducer calibration procedure.

3.6 Preprocessor Device ID Entry

This procedure is only required if the microprocessor is not reading the device ID from the preprocessor board, or if the preprocessor board has been replaced.

1. From the `HIDDN MENU` set the **`SERIES`** `to` **`A`** `or` **`B`** depending on which analyzer it is. Then press Enter> (↵).
2. Set the **`ANALYSER TYPE`** `to` **`9832`** and press Enter> (↵).
3. The display should now display `9832 CO ANALYZER`.
4. You may need to erase memory after this procedure to avoid any problems.
5. From the `HIDDN MENU` set the the **`ANALYSER SUBTYPE`** `to` **`HIGH LVL`**. Then press Enter> (↵).
6. The display should now display `9832 CO ANALYZER`.

This completes the analyzer device type programming.

3.7 Firmware Update

As improvements are made to the EC9800 series analyzers, these can be easily passed on to the user by updating the firmware (software operating within the Microprocessor board).

To update your EC9800 Analyser, download the Firmware Updater Software. Install this software on a Windows based computer with a COM port. To do this, run the downloaded file 'setup.exe' by double clicking on it, then follow the installation screens to install.

Next, download the required software version for your 9800 analyser from those listed at the bottom of this page (eg V1.00.0002), by right clicking on the link, and choosing 'Save Target As', and saving the .sx file on your computer. You will need to select save as type 'All Files' in the download window.

To update the firmware on the analyser:

1. Run 'Firmware Updater' from the 'Start - Programs - Ecotech - Firmware Updater' menu.
2. Connect the 9800 analyser to the computer using a standard serial cable (you must connect to the Multidrop port on the back of the analyser).

3. Select 'Serial Port' and the COM Port on the computer from those listed on the Firmware Update screen.

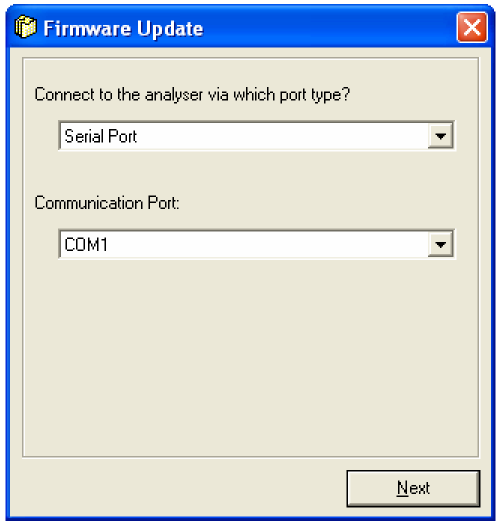


Figure 24 Firmware Update communication settings screenshot

4. Click Next

5. Enter the full path and file name of the firmware (.sx) file you downloaded. eg - C:\TEMP\V1.03.0001.SX assuming the file was saved to C:\TEMP.

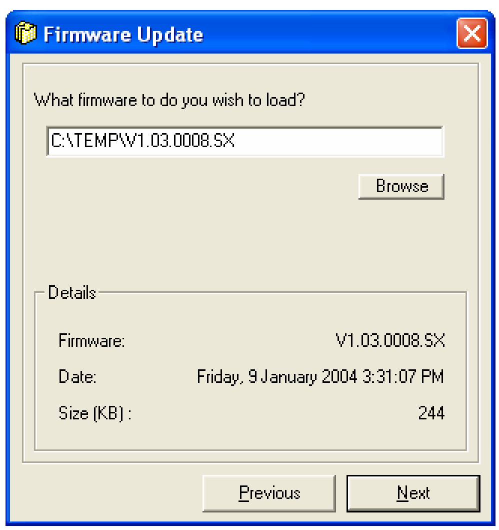


Figure 25. Firmware Update firmware selection screenshot

6. Click Next

7. Tick the boxes as shown in the figure below.

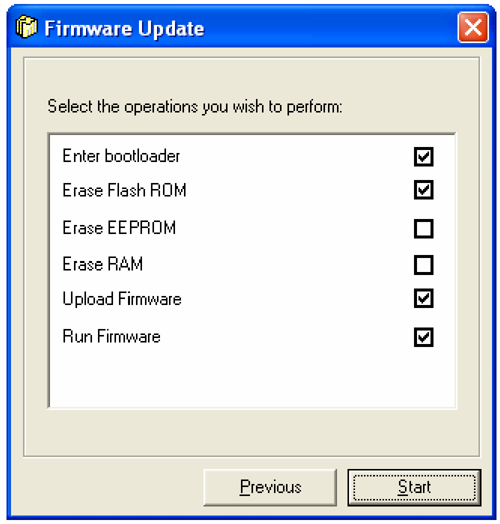


Figure 26. Firmware Update operations screenshot

8. Ensure the analyser is switched off using the switch under the front panel.

9. Click 'Start'.

10. Switch the analyser on.

11. The Firmware Updater window will show each step as the firmware is uploaded. DO NOT turn the analyser off until the 'Close' button is enabled as shown below, and the Analyser is operating as usual again.

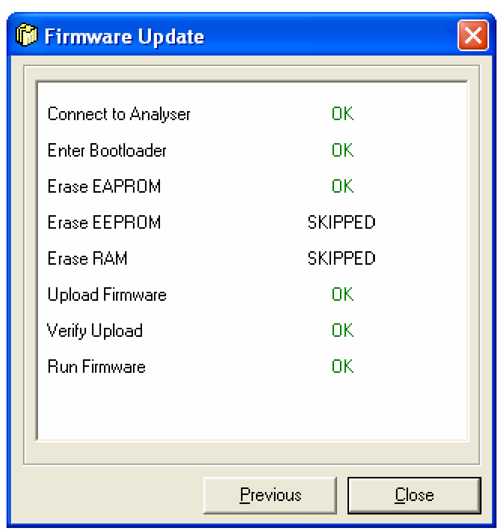


Figure 27. Firmware Update completion screenshot

4.0 Troubleshooting

4.1 DC Power Supply Voltages

Before consulting the troubleshooting section, verify that the DC power supply voltages are present and within the specifications given for each printed circuit board listed in the following table. Circuit board illustrations indicating the test points and other component locations immediately follow the Troubleshooting Guide.

Table 1. Troubleshooting Voltages

PCB	Supply	DVM(-)	DVM(+)	Response
Microprocessor	+12V GOOD* -10 v -20 v	TP1 (PGND)	TP2 TP3 TP4	+20 ±0.5 v -10 ±0.5 v -20 ±0.5 v
Voltage Reg.	+12 v +10 v -10 v +5 v	TP7 (AGND)	TP9 TP8 TP6 TP4	+12 ±0.5 v +10 ±0.5 v -10 ±0.5 v +5 ±0.25 v
Preprocessor	+12 v +5 v +10 v +1 v (COOLER) +6 v (SOURCE)	TP2 (AGND)	J2-1, J2-6 J2-3 J2-4 J5-5 J3-3	+12 ±0.5 v +5 ±0.25 v +10 ±0.5 v +1 ±0.3 v +6 ±0.3 v
Flow Control (A Series)	+5VL +4.5VB +12V	TP1 (AGND)	J2-1 J2-4 J2-8	+5 ±0.25V +4.5 ±0.25V +12 ±0.5V
Flow/Pressure (B Series)	+10V -10V	TP2 (AGND)	J1-4 J1-5	+10V ±0.5V -10V ±0.5V

* The +12V GOOD test point is a 5 volt status output from the power supply to indicate that the Mains supply is within the correct operating range.

4.2 Troubleshooting the EC9832 Analyzer

Because of the sophisticated design of the EC9832 analyzer, a significant amount of information about the condition of the system is available on the front panel display**.** You can therefore troubleshoot an operating instrument without opening the front cover.

The most useful menus in terms of troubleshooting are:

`PREPROCESSOR POTS`

```
VALVE TEST MENU
EVENT LOG
INSTRUMENT STATUS
SYSTEM TEMPERATURES
SYSTEM FAULTS.
```

These menus provide information that may indicate a failure or an operational problem. If instrument performance appears to have changed dramatically, the component that is causing the problem can possibly be determined, thereby speeding up the corrective process. It may assist the operator to periodically check and record these parameters to establish an operational history of the analyzer. In addition, information from this section may be requested by the Ecotech Service Support personnel when assistance is required.

4.2.1 Preprocessor Pots Menu

```
                 PREPROCESSOR POTS

MEASURE COARSE ZERO  :  67 (50-80)
MEASURE FINE ZERO    :  4  (1-99)
INPUT                :  45
REFERENCE GAIN       :  0
TEST MEASURE         :  0

REF. VOLTAGE      3.70 - 4.30     VOLTS
CO                0 - 200         PPM
CONC. VOLTAGE     0 - 4.5         VOLTS
```

Figure 28. Preprocessor Pots and Ranges

The PREPROCESSOR POTS screen displays the potentiometer settings associated with several components, variables, or signals on the preprocessor board. Figure 28 illustrates a typical screen for an instrument that is operating normally. The value of the potentiometer settings is somewhat arbitrary and differences in the examples shown here and the values displayed on an operating instrument should not be construed as a definite indicator of a problem. Potentiometer settings of 99 and 0, however, represent the extreme limits of the potentiometer range and may be reason to suspect a problem, except for TEST MEASURE, which is zero unless changed by the operator.

4.2.2 Flow Control Pots Menu (A Series only)

The FLOW CONTROL POTS screen displays the potentiometer settings associated with several components, variables, or signals on the A series Flow Control board. Figure 29 illustrates a typical test screen for an instrument that is operating normally. Like the PREPROCESSOR POTS, the value of the potentiometer settings is somewhat arbitrary. Potentiometer settings 99 and 0, however, represent the

extreme limits of the potentiometer range and may be reason to suspect a problem.

```
                FLOW CONTROL POTS

FLOW CONTROL ZERO  : 81 (50 –90)
FAN SPEED CONTROL  : 16 (0 - 99)
PUMP SPEED FINE    : 85 (0 - 99)
PUMP SPEED COARSE  : 62 (20 - 60)


GAS FLOW            1.500  SLPM
GAS PRESSURE        585.6  TORR
```

Figure 29. Flow Control Pots Range

4.2.3 Valve Test Menu

```
                 VALVE TEST MENU

INT. VALVE #1          :  OPEN
INT. VALVE #2          :  CLOSED
INT. VALVE #3          :  CLOSED
EXT. MEASURE           :  CLOSED
EXT. ZERO GAS          :  CLOSED
EXT. SPAN GAS          :  CLOSED
AUX. VALVE #1          :  CLOSED
AUX. VALVE #2          :  CLOSED
VALVE SEQUENCING       :  ON
```

Figure 30. Valve Test Menu

The `VALVE TEST MENU` (see Figure 30) displays the current status of each valve in the instrument. This menu can be particularly useful in correcting flow problems in the machine. The valves can be opened and closed from this menu, thus allowing the operator to determine whether valves are operating correctly. Valve sequencing must be `ON` in order for correct gas measurement to be accomplished.

4.2.4 Event Log

Upon noting a possible operational problem, examine the `EVENT LOG` menu to determine whether the microprocessor is reporting a system failure or problem. Should the `EVENT LOG` indicate an error, it will also provide information as to the portion or component of the instrument which is at fault.

Event Log Messages		
Message	**Description**	**Action**
RAM CHECKSUM FAILURE	Checksum of memory at power down differs from checksum at restart.	Battery failure or system software error. If error persists, call Ecotech Customer Service for instructions.
EAROM X DATA ERROR Y	EROM designated X detected error at location Y.	Check pressure board cable connections and pressure board.
SERVICE SWITCH ACTIVATED	Unit taken out of service from front panel.	Return analyzer to service using the front panel switch.
LCD DISPLAY BUSY	LCD constantly busy indicates hardware failure in display.	Check display cable connection, display board, and microprocessor board.
A/D CONVERSION ERROR	A/D returned busy status	Normal at startup. If failure persists, replace microprocessor.
SYSTEM POWER FAILURE	Power removed from system.	No action required.
SYSTEM POWER RESTORED	Power applied to system.	No action required.
ZERO POT LIMITED TO 0 OR 99	Zero voltage controller reached limits before voltage reached set point.	Reset analyzer, check zero air source.
INPUT POT LIMITED TO 0 OR 99	Input controller reached limits before reference voltage reached set point.	Check IR source.
ZERO FLOW	Instrument flow has gone to zero.	The pump has failed or a flow obstruction has occurred. Replace pump, or clear obstruction.
SPAN RATIO <0.75	After AZS cycle, ratio of requested span to measured span is <0.75.	Instrument span has drifted beyond acceptable limits. Recalibrate.
SPAN RATIO >1.25	After AZS cycle, ratio of requested span to measured span is >1.25.	Instrument span has drifted beyond acceptable limits. Recalibrate.
ELECTRONIC ZERO ADJUST	An analyzer electronic zero cycle was initiated.	Normal after reset or power failure. If not associated with these, check zero air supply.
BACKGROUND CYCLE	Background cycle started. The value of the result of the previous background is stored here.	No action required.

Event Log Messages		
Message	**Description**	**Action**
RESET DETECTION	Reset button pressed or watchdog timer caused reset.	Unless the reset was not initiated by the user, no action is required.
AZS CYCLE	AZS cycle started.	No action required.
CHOPPER WHEEL ERROR	Indicates that the chopper wheel is not operating correctly.	Check chopper motor, opto-interrupter and chopper wheel.
DATA LOGGING MEM FAIL	Occurs if unable to write to datalogging memory.	Battery failure or system software error. If error persists, call Ecotech Customer Service for instructions.
CONTROL LOOP RESTARTED	Occurs when Control Loop has been disabled, and then automatically enabled after the main screen has been visible for the last 1 minute.	No action required.
CHASSIS TEMP. THRESHOLD	Occurs if chassis temp varies by 4C, then 3 successive backgrounds will be performed each hour.	No action required.
VALVE SEQUENCING RESTARTED	Occurs when valve sequencing has been disabled, and then automatically enabled after the main screen has been visible for the last 1 minute.	No action required.

4.2.5 Instrument Status

```
                    INSTRUMENT STATUS

GAS FLOW          :  1.4 – 1.6      SLPM
GAS PRESSURE      :  430 - 800      TORR
REF. VOLTAGE      :  3.80 - 4.20    VOLTS
CONC. VOLTAGE     :  0 - 4.50       VOLTS
ANALOG SUPPLY     :  11.6 - 12.2    VOLTS
DIGITAL SUPPLY    :  4.8 - 5.2      VOLTS


VERSION 1.03.0002                       EXIT
```

Figure 31. Instrument Status and Ranges

The INSTRUMENT STATUS screen provides information about several critical parameters in the EC9832. If any of the parameters displayed on the INSTRUMENT STATUS screen vary significantly from the values shown in Figure 31, the fault or operational problem is probably related. This is also true if one of the parameters is demonstrating a rapid change or is oscillating strongly around the desired setpoint.

Several of the parameters displayed on the INSTRUMENT STATUS screen are affected by the potentiometer settings on the PREPROCESSOR POTS screen. If a parameter is out of the normal operating range, make note of the parameter value, proceed to the applicable menu, and examine the pertinent potentiometer settings.

4.2.6 System Temperatures

```
                  SYSTEM TEMPERATURES

   CELL TEMP.        :  47 - 53       DEG C
   CONV. TEMP.       :  87 - 93       DEG C
   CHASSIS TEMP.     :  15 - 55       DEG C
   FLOW TEMP.        :  45 - 55       DEG c
   COOLER TEMP.      :  1.0 - 1.2     VOLTS
   MIRROR TEMP.      :  47 - 53       DEG C

                                              EXIT
```

Figure 32. System Temperatures and Tolerances

The SYSTEM TEMPERATURES screen provides the temperatures of the measurement cell, the chassis temperature, and the thermoelectric cooler temperature used to cool the detector. Figure 32 contains the nominal values that should be displayed on this screen. If any of the parameters are outside the acceptable ranges, a significant problem among these components is strongly indicated.

4.2.7 System Faults

The SYSTEM FAULTS display provides pass/fail indications for various parameters that are continually monitored. These parameters must be within acceptable operating ranges in order to display PASS. If FAIL is indicated, this indicates a major failure in that area. If the instrument is in startup mode, START will be displayed.

Note

The SYSTEM FAULTS screen only indicates PASS or FAIL for the various analyzer parameters, and is meant to indicate major failures. Desired operating ranges are indicated in the INSTRUMENT STATUS and SYSTEM TEMPERATURE ranges section. If analyzer readings are not within these ranges, it could indicate deterioration of certain assemblies within the analyzer, or minor failures.

The following table lists the possible system fault messages that are displayed on the primary screen if a major failure occurs. If a fault message is displayed, use the troubleshooting guide to find the possible cause of the fault.

System Fault Messages	
Message	**Description/Failure Limits**
OUT OF SERVICE	Indicates the Service switch is in the OFF position. Unless the analyzer is being serviced, this switch should be in the IN position.
ZERO FLOW (A series)	Indicates that the sample flow is less than 0.1 slpm.
ZERO FLOW (B series)	Indicates that the gauge pressure from the Pressure PCA is less than 20 torr (bad pump or plugged orifice) or greater than 200 torr (plugged inlet). Can also occur if the sample inlet is pressurized.
LAMP/SOURCE FAILURE	Indicates that the source voltage is not within the acceptable limits. A fault is indicated if the cooler voltage falls ***below*** 0.5 volts.
CHOPPER WHEEL FAILURE	Indicates that the chopper (correlation) wheel is not rotating.
COOLER FAILURE	Indicates that the cooler temperature or voltage is not within the acceptable limits. A fault is indicated if the cooler voltage is ***above*** 1.5 volts.
REFERENCE VOLTAGE OUT OF RANGE	Indicates that the reference voltage is not within the acceptable limits. A fault is indicated if the reference voltage is ***below*** 3 volts or ***above*** 4.5 volts.
12 VOLT SUPPLY FAILURE	Indicates that the 12 volt supply voltage is not within the acceptable limits. A fault is indicated if the 12 volt supply voltage is ***below*** 11.1 volts or ***above*** 14.3 volts.
CELL TEMPERATURE FAILURE	Indicates that the cell temperature is not within the acceptable limits. A fault is indicated if the cell temperature is ***below*** 35° C or ***above*** 60° C.
CONVERTER TEMPERATURE FAILURE	Indicates that the converter temperature is not within the acceptable limits. A fault is indicated if the converter temperature is ***below*** 80° C or ***above*** 100° C.
MIRROR TEMPERATURE FAILURE	Indicates that the mirror temperature is not within the acceptable limits. A fault is indicated if the mirror temperature is ***below*** 35° C or ***above*** 60° C.

System Fault Messages	
Message	**Description/Failure Limits**
`FLOW BLOCK TEMP`	Indicates the flow block temperature is not within acceptable limits. A fault is indicated if the flow temperature is ***below*** 35° C or ***above*** 60° C.
`START UP SEQUENCE ACTIVE`	Indicates that the analyzer is in start-up mode. Usually after power-up or reset.

4.3 Test Functions

The following lists the available diagnostic modes in the EC9832 under the `TEST MENU`:

4.3.1 Optic

Not supported.

4.3.2 Preamp

The preamp test function generates an electronic test signal which is applied to the input of the IR detector preamp. This simulates an input from the detector and is then processed as if it were an actual signal. This test is used to verify the operation of the detector.

4.3.3 Electric

The electric test function generates an electronic test signal which is applied to the input of the preprocessor. This simulates a reference and measure input to the preprocessor and is then processed as if it were an actual signal. This test is used to verify the operation of the preprocessor board reference and measure channels.

4.3.4 Use of Diagnostic Modes

The diagnostic mode is actuated by selecting `DIAGNOSTIC MODE: ELECTRIC or PREAMP,` and adjusting the test measure or test reference potentiometer until a response (simulated concentration or reference) is noted. Response to tests will vary depending upon individual analyzer parameters. These tests are typically pass/fail (response or no response).

4.4 Troubleshooting Guide

Use this troubleshooting guide to find the symptom, then follow in order the possible causes and fault isolation/solutions until the problem is discovered and take the action described.

If you cannot identify the problem, contact Ecotech at the locations given in the front of this manual.

System Troubleshooting Table		
Symptom	**Possible Cause**	**Fault Isolation/Solution**
1. No display/ instrument dead	AC power	1. Verify that the line cord is connected. 2. Check that the power supply fuse is not open. The fuse should be 5A (115 v) or 3A (230 v). 3. Verify that the voltage switch is in the proper position.
2. No display	Contrast maladjusted	Set or adjust the display contract by simultaneously pressing two keys on the front panel as follows: - *Contrast*: Press Up Arrow (↑) and <Select> for darker contrast, Down Arrow (↓) and <Select> for lighter contrast.
	DC power	1. Verify the cable connection from the power supply to the Vreg board. 2. Check the Vreg board for correct voltages as listed in the troubleshooting voltages table in section 4.1 above. If incorrect voltages are found, replace the power supply. 3. Check Microprocessor test points listed in the Troubleshooting Voltages table in section 4.1.
	Display	Check the interface cable between the display and J6 on the microprocessor board.
	Bad Display or microprocessor board	1. Replace the front panel display. 2. Replace the microprocessor board. 3. A bad cable is unlikely, but if you suspect it, perform a pin-for-pin continuity test using an ohmmeter.
3. Zero Flow	Pump failed	Replace the pump.
	Filter	Check the particulate filter. Replace if dirty or plugged.
	Flow control assembly (A Series)	Recalibrate the flow control assembly.
	Pressurized Rx Cell	Ensure Sample and Zero inlets are maintained at ambient pressure.
	Plugged Orifice or SS Filter (B series)	Clean or replace the orifice and SS filter.
4. Noisy or unstable readings	Leaks	A leak dilutes the sample stream and causes low span readings and noise. See the leak test procedure in section 3.3.10 above.
	IR source weak or noisy detector.	Adjust the detector signal. If you are unable to obtain an acceptable reading, replace the source or detector.

System Troubleshooting Table		
Symptom	**Possible Cause**	**Fault Isolation/Solution**
	Cell Heater/Mirror Heater	A failed temperature control allows the instrument zero to drift with ambient temperature. Verify that the cell temperature and mirror temp are 50° ±3° C *and stable* (±0.3° C).
5. Low span	Span setting	Adjust the span using the calibration procedure in the *EC9832 Operation Manual*.
	No flow	See the zero flow symptom in this table.
	Correlation Wheel Leak	Check the preprocessor pots/measure coarse zero setting. If it is below 50, replace the correlation wheel.
	Leaks	A leak dilutes the sample stream and causes low span readings and noise. See the leak test procedure in section 3.3.10 above.
6. No response to span gas	Leaks	A leak dilutes the sample stream and causes low span readings and noise. See the leak test procedure in section 3.3.10 above.
	No flow	See the zero flow symptom in this table.
	Correlation Wheel Leak	Check the preprocessor pots/measure coarse zero setting. If it is below 50, replace the correlation wheel.
	Software lockup	1. Observe whether `ECOTECH GLOBE` on the display is turning. 2. Verify that other menus can be selected. 3. Press the Reset button on the secondary panel. 4. Check that D5 HEART BEAT LED is flashing on the Microprocessor Board
7. Zero drift	CO-CO_2 converter failed	Replace the converter.
	Leak	A leak dilutes the sample stream and causes low span readings and noise. See the leak test procedure in section 3.3.10 above.
8. Unstable flow or pressure readings	Failed pressure board	Recalibrate flow/pressure board. Replace board if symptoms persist.
9. Instrument stuck in reference adjust	Reference voltage	Perform detector signal check and adjustment.
10. Response time not at specified value	Low Flow	Check sample flow with flow meter. It should be 0.8 to 1.2 slpm at STP. Replace inlet filter, SS filter, or orifice if it is not.

System Troubleshooting Table		
Symptom	**Possible Cause**	**Fault Isolation/Solution**
11. Analyzer displays `BAD I.D. ANALYZER`	Preprocessor ID set wrong	1. Check J5 connector on Microprocessor. 2. Check J4 connector on Preprocessor. 3. Reprogram device ID. 4. Replace Preprocessor

INDEX